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MATHILDE MUNOZ

ESSAYS ON TAXATION AND INTERNATIONAL WORKER MOBILITY IN EUROPE

Supervised by: Thomas Piketty

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Thèse dirigée par: Thomas Piketty

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Summary

This thesis is a collection of four single-authored essays that analyze the implications of international worker mobility for redistribution and welfare, using the European Union as a laboratory.

The first chapter shows that the geographic mobility of workers leads non-tradable jobs to be offshored "on-site" and carries large redistributive implications for workers and governments. Posting policies, that were first introduced in the European Union, allow firms in one country to send ("post") their workers to perform such services in another country. I combine novel administrative data on posting missions in Europe, quasi-experimental variations in the policy, and a model of trade in services, to evaluate the redistributive implications of exposing novel jobs to international competition. I show that the staggered liberalization of posting to low wage countries permanently increased trade in services in Europe: 2% of EU GDP is offshored "on-site" through posting, mostly in "non-tradable" sectors, while within-EU geographic mobility is twice as large once accounting for posted workers. In receiving countries, domestic employment in exposed sectors and local labor markets differentially decreased following the liberalization. These market-level employment effects are driven by posted workers being substitutes for domestic blue collar workers at receiving firms, and posting services being cheaper. I then demonstrate that posting openness triggered large economic gains in low-wage sending countries: firms in formerly "non-tradable" sectors increase their sales, profits and wages when accessing foreign markets through posting. Calibrating a model of trade in services with estimates of the posting elasticity, I finally quantify that the liberalization increased European consumers' welfare by 0.3% on average. My results suggest that expanding the range of tradable jobs through posting policies, as proposed in several major recent trade agreements, can hurt low-paid workers in high wage countries, benefits sending firms in low wage countries, and has small efficiency effects for consumers.

In the second chapter, I study a novel channel through which tax differentials affect the international mobility of workers in a globalized world: trade-in-services. When countries trade, firms can send their employees abroad to supply services locally. Using Europe as a laboratory, I show that labor tax rules set in trade treaties affect the international mobility of workers through trade-in-services. This novel trade-migration response to taxes carries two central implications for tax and trade policies: (i) tax-induced international mobility of workers is larger than previously thought and (ii) tax competition matters for comparative advantages in services. I first set out a theoretical model of taxation and cross-border services supplied

by mobile “posted” workers, that illuminates the role of tax policy for the spatial allocation of workers and services: tax rules for posted workers jointly determine the international mobility of employees and the geography of trade in services. Next, I turn to quasi-experimental evidence exploiting the implementation of preferential tax schemes for foreign workers in both receiving and sending countries. I show clear graphical evidence of international trade-migration responses to taxes, with reduced-form trade-migration elasticities with respect to taxes that are above one. I then present theory-consistent estimates of a gravity model, that yield a structural estimate of the trade-migration elasticity of 1.1, consistent with the reduced-form results. Using those estimates, I quantify that enforcing tax cooperation in current European trade treaties, as recently proposed by the European parliament, would decrease trade-migration flows within the EU by roughly 30%, and would mostly affect exports of services from low-cost countries.

The third chapter studies the effects of top income tax rates on top earners’ migration, using a novel individual dataset on mobility representative of the entire population of 21 European countries. It exploits the differential effects of changes in top tax rates on individuals at different earnings levels. I find that top earners’ location choices are significantly affected by top income tax rates. The elasticity of the number of top earners with respect to the net-of-tax rate is between 0.1 and 0.3; it is around one for foreigners. Migration elasticities differ widely across member states, leading to different incentives to implement beggar-thy-neighbour tax policies within Europe. Member states with more foreigners and more managers in their tax base are more sensitive to tax-induced mobility of top earners compared to countries where high income residents are vastly domestic workers and have less mobile human capital, such as civil servants or doctors.

The fourth chapter quantifies the welfare effects of tax competition in an union where individuals can respond to taxation through migration. I derive the optimal linear and non-linear tax and transfer schedules in a free mobility union composed by symmetric countries that can either compete or set a federal tax rate. I show how in the competition union, the mobility-responses to taxation affect the redistributive capacity of governments through several mechanisms. I then use empirical earnings’ distribution and estimated migration elasticities to implement numerical calibrations and simulations. I use my formulas to quantify the welfare gains and losses of being in a tax competition union instead of a federal union, and show how these welfare effects vary along the earnings distribution. I show that even when migration elasticities are small, and far below unity, the bottom fifty percent always loses from tax competition. My results show that being in a competition union rather than in a federal union with a uniform tax rate could decrease poorer individuals welfare up to -20 percent.

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Introduction Générale

La mobilité des travailleurs génère des gains de productivité et d'efficacité parce qu'elle permet une meilleure allocation des facteurs de production dans l'espace. Par exemple, une étude publiée en 2019 dans l'American Economic Review par Trevor Tombe et Xiaodong Zhu établit que la baisse des restrictions à la mobilité interne des travailleurs chinois entre 2000 et 2005 explique la majorité des gains agrégés de productivité observés en Chine sur cette période. La littérature économique décrit depuis longtemps la mobilité des facteurs de production comme une condition centrale du fonctionnement des unions commerciales et monétaires: elle permet aux individus de s'assurer contre les chocs conjoncturels asymétriques, aux travailleurs de s'établir là où leur valeur économique et sociale est la mieux rémunérée et répond aux pénuries de main d'oeuvre et de formation frappant certains segments du marché du travail.

Parce qu'intimement lié à celui de l'efficacité du marché, le sujet de la mobilité des travailleurs occupe depuis longtemps une place centrale dans la politique économique européenne. Depuis la ratification du traité de Rome en 1959, l'intégration européenne s'appuie sur trois principaux piliers. La liberté de circulation permet aux citoyens européens de s'installer et travailler librement dans chacun des pays de l'Union Européenne. La liberté d'établissement autorise les entreprises et les indépendants à exercer leur activité sur le territoire de tout Etat membre. Finalement, la liberté de prestation de services permet aux entreprises d'envoyer leurs travailleurs effectuer une mission de services dans un autre pays européen, disposition ayant donné lieu au régime des travailleurs détachés.

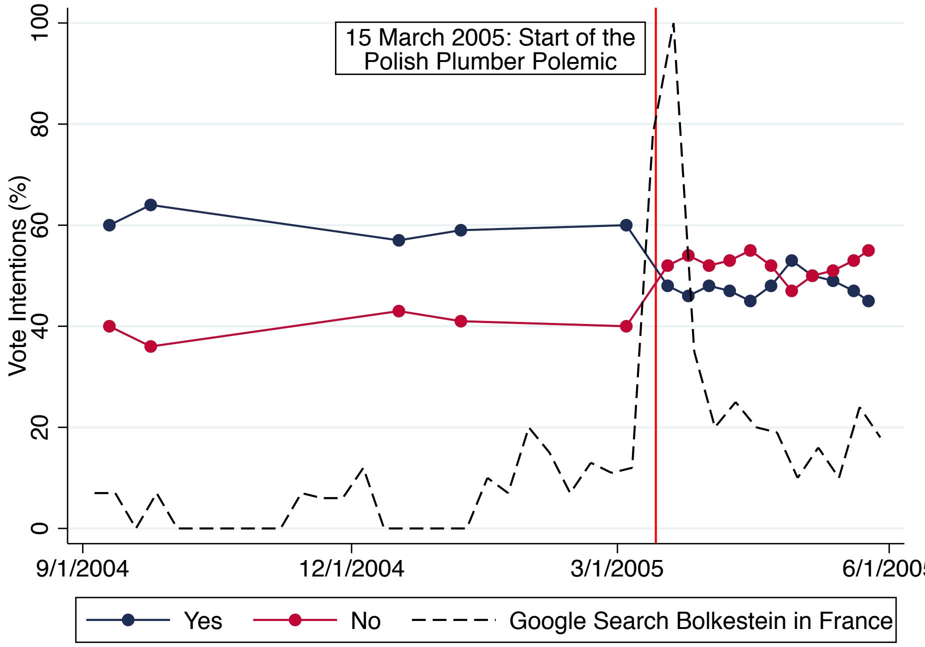
Bien que la migration intra-européenne reste 10 fois moins élevée qu'aux États-Unis, son augmentation a été soutenue depuis vingt ans. Cette tendance s'explique principalemement par les élargissements de 2004 et 2007 et par les mouvements migratoires entrainés par la crise des dettes souveraines dans le sud de l'Europe. Ces flux migratoires récents restent cependant de faible ampleur en comparaison aux grands épisodes de migration ayant marqué l'histoire de la construction européenne. Entre 1960 et 1980, l'Espagne, le Portugal et la Grèce ont vu émigrer jusqu'à 15 % de leur population active, contre moins de 4 % en moyenne depuis 2007. Ces mouvements restent enfin très inégalement répartis sur le territoire européen: par exemple, 60 % de l'émigration polonaise depuis 2004 a été absorbée par l'Angleterre et l'Irlande quand la plupart des pays européens n'ont été que peu affectés par ces flux de migration venus de l'est. Au cours de la même période, la mobilité internationale des travailleurs via les prestations internationales de services connaissait un essor vertigineux, se matérialisant par une hausse quasi exponentielle du phénomène depuis 2005. Cette augmentation de la mobilité internationale des travailleurs par le commerce international de services a été globalement peu anticipée par les gouvernements européens et mieux répartie entre les pays d'Europe de l'Ouest. Illustrant l'ampleur du phénomène, les données sur les formulaires de détachement dénombraient 2 millions et demi de travailleurs détachés en 2018 contre 1 million d'européens immigrant dans un autre Etat membre la même année. Le principe de libre prestation des services contribue désormais au même titre que le principe de libre circulation des travailleurs à l'allocation des travailleurs dans l'espace européen.

David Beckham et le Plombier Polonais

Bien que le projet politique européen se cristallise depuis le traité de Rome autour de l'intégration économique à travers ces trois axes de libéralisation- marché des capitaux, marché des biens et services et libre circulation des personnes- les politiques fiscales et sociales européennes restent largement soumises aux prégoratives nationales. L'Union Européenne constitue donc un laboratoire unique, où la baisse rapide des barrières à l'échange et à la mobilité côtoie de larges différentiels de taxes, qui ont été accentués par les élargissements successifs de l'Union Européenne. A titre d'exemple, le taux marginal supérieur d'imposition sur le revenu était de 20% en Pologne, 43% au Luxembourg et 55% au Danemark en 2015. La même année, le taux de contribution sociale était de moins de 15% au Luxembourg, en Irlande ou en Slovénie, mais avoisinait les 40% en France ou en Belgique. Quant au salaire minimum légal mensuel, il s'étendait de 184 euros en Bulgarie à 1,500 euros en Belgique, quand d'autres pays comme l'Italie ou l'Autriche en étaient tout simplement dépourvus, laissant le soin aux accords collectifs de réguler les taux de rémunération.

La concomitance de cette intégration internationale d'une part, et de ces hétérogénéités fiscales et sociales d'autre part, a généré de vif débats au sein de l'opinion publique européenne. Une des illustrations les plus frappantes a été donnée par l'épisode de la directive des services de 2005. Si les travailleurs détachés dans un pays continuent de payer leurs charges sociales dans leur pays d'origine, et ne sont pas soumis au code du travail du pays de destination, la Directive Européenne de 1996 établissait jusqu'alors que le salaire minimum légal du pays d'accueil devait s'appliquer. En 2005, une directive portée par le commissaire Frits Bolkestein propose d'abandonner ces clauses anti-dumping jugées protectionnistes, et d'appliquer exclusivement les règles du pays d'origine aux travailleurs détachés, y compris celles relatives au salaire minimum. S'emparant des craintes de compétition déloyale générées par cette proposition, Philippe de Villiers popularise le 15 mars 2005 l'expression de « plombier polonais » dans une tribune largement reprise en France et en Europe. La polémique intervient en pleine campagne pour l'adoption d'un traité constitutionnel européen et bouleverse l'opinion publique francaise, cristallisant les craintes d'un "moins-disant fiscal et social" Européen en l'absence d'harmonisation des législations nationales. Face aux nombreuses protestations et manifestations suivant l'introduction du texte de loi au Parlement européen , Jacques Chirac appelle à un retrait immédiat d'une régulation jugée « inacceptable » par la France. Les données des intentions de vote pour le référendum de 2005 (voir figure infra) montrent un clair infléchissement du soutien à l'intégration européenne après le début de la polémique, indiquant que la question de la fiscalité européenne des travailleurs mobiles a joué un rôle central dans le rejet du traité européen par les électeurs français.

Figure 1: **Support for European Integration and the Posting Policy**



Notes: This Figure shows the effects of labor posting policy on support for European integration in one of the main European receiving country: France. In 2005, a referendum to adopt a European constitution was implemented in France. The Figure shows the vote intention, where "yes" denotes the option to increase European political integration. In march 2005, a proposition was made at the European commission to further liberalize the European posting policy, by exempting posted workers from all country of work regulations, including the minimum wage. This proposition (the Bolkestein proposition) led to massive debates in receiving countries, and gave birth to the "polish plumber" polemic the 15th of March 2005 when one of the main "no" leader, Philippe de Villiers, wrote a text evaluating that further services exports mobility liberalization will lead millions of French workers to loose their jobs. The same day, the number of searches for Bolkestein rose sharply in France. Few days after the polemic, the vote intentions against European integration rose, leading to reject the European political project in june.

Depuis 2005 et la polémique Bolkestein, les questions relatives à la régulation sociale et fiscale des plus mobiles ont continué d'occuper une place de choix dans les débats politiques nationaux. Quelques mois après son élection en 2017, Emmanuel Macron qualifiait la politique européenne de détachement « de trahison à l'esprit européen dans ses fondamentaux » lors d'une visite en Autriche, puis de « dumping fiscal » menaçant de « démanteler l'Europe » une semaine plus tard à Bucarest. Dans le même temps, la fiscalité des salariés mobiles les plus riches a aussi été au centre de nombreuses polémiques, tout aussi anciennes que celles relatives aux travailleurs détachés. En 2005, l'Espagne créait une exonération fiscale pour les super riches, surnommée Beckham law, parce qu'en partie imaginée pour la venue du joueur au Real Madrid, générant des remous au sein des partis de gauche indignés par les inéquités fiscales entrainées par le régime. Quelques années plus tard, la demande de nationalité belge effectuée par le milliardaire Bernard Arnaud après l'élection de François Hollande en 2012 mettait également en exergue les risques de politiques fiscales non-coopératives provoquées par la mobilité internationale des contribuables les plus riches. Dans une étude publiée conjointement avec Henrik Kleven, Camille Landais et Stefanie Stantcheva, nous avons montré que de nombreux pays européens ont désormais adopté des régimes fiscaux préférentiels pour les salariés mobiles les mieux rémunérés. Ces exonérations fiscales sont de plus en plus avantageuses, et démontrent une concurrence fiscale intra-européenne féroce pour encourager la mobilité de certains travailleurs qualifiés. Paradoxalement, ces régimes visant à favoriser les salariés mobiles les plus riches sont particulièrement répandus dans les pays de l'Ouest et du Nord de l'Europe, ceux-là même qui ont la position la plus dure vis-à-vis des exonérations accordées aux travailleurs détachés. Le cas français illustre bien cette position. Le régime des « impatriés » introduit en 2004 acccorde aux travailleurs nouvellement arrivés en France, et ce pour une durée totale de 8 ans, une exonération d'impôt sur le revenu pouvant aller jusqu'à 50 % de la rémunération globale reçue en France, de 50 % du montant de certains revenus perçus à l'étranger (en particulier des revenus de la propriété intellectuelle, des plus-values et revenus du capital), et une exonération totale d'impot sur la fortune pour l'ensemble des bien détenus à l'étranger. Depuis 2015 et la loi Macron, le champ du régime est étendu aux charges patronales, en permettant l'exonération de la taxe sur les salaires, une taxe majoritairement payée par les banques et les assurances. Enfin, dans l'optique du Brexit, le gouvernement a facilité l'utilisation du régime pour les mobilités intra-entreprises, permettant aux grands groupes internationaux de rapatrier leurs cadres en France à moindre coût fiscal. En vue d'attirer les investisseurs londoniens, l'imposition des « carried interests » a également été limitée à 30 % pour les gérants de fonds d'investissements étrangers s'installant en France à partir de 2019. Le Portugal, et plus récemment l'Italie, ont également introduit des régimes fiscaux agressifs visant à attirer les riches contribuables européens, notamment retraités, sur leur territoire.

Si la politique du détachement et celles concernant les salariés impatriés peuvent sembler différentes tant par la population à laquelle elles s'adressent que par le discours politique qui les justifie, les mécanismes économiques sous-jacents à ces dispositifs fiscaux sont pourtant similaires. Dans les deux cas, il s'agit d'encourager la mobilité internationale des contribuables en réduisant la charge fiscale, sociale et administrative s'appliquant aux travailleurs internationalement mobiles. Dans les deux cas, les gouvernments font l'hypothèse que les décisions de mobilité géographique sont affectées significativement par les différentiels de taxes, et adaptent leur système redistributif en conséquence. Du plombier polonais à David Beckham, les réponses migratoires aux différentiels de taxes influencent les politiques fiscales nationales, et peuvent mener à un moins-disant fiscal. En l'absence de coordination fiscale et sociale, les flux de mobilité générés par la libre circulation des travailleurs d'une part, et la libre prestation de services d'autre part, posent donc de nouveaux défis pour les politiques fiscales nationales.

Quel est l'effet de l'intégration internationale sur la capacité redistributive des gouvernements? Comment adapter les politique fiscales et sociales aux défis posés par la mobilité internationale des travailleurs, tant via la libre circulation des personnes que par la libre prestation des services? La compétition fiscale affecte-t-elle le bien-être des citoyens de manière différenciée selon leur position dans la distribution des revenus? Cette thèse propose d'apporter un nouvel éclairage sur l'intéraction entre politiques fiscales et mobilité internationale des travailleurs en Europe, et d'en quantifier les effets redistributifs pour les citoyens Européens. Chacun des chapitres mobilise de nouvelles données et outils théoriques pour mettre en lumière les effets redistributifs de l'intégration internationale en l'absence de coordination fiscale ou sociale.

Le premier chapitre s'appuie sur de nouvelles données et quantifie pour la première fois les effets redistributifs de la politique du travail détaché en Europe. Ce travail permet d'éclairer les différents effets de cette politique pour les pays d'origine, les pays de destination, ainsi que pour les consommateurs Européens. L'analyse indique que l'ouverture à la compétition internationale du secteur des services par la politique du détachement a entrainé des pertes d'emplois dans les secteurs exposés des pays riches, et a généré des gains de parts de marché, de chiffre d'affaire et de revenus fiscaux dans les pays à bas salaires. Les gains économique de l'intégration des services permise par la mobilité des travailleurs détachés sont principalement capturés par les employeurs, tant dans les pays de destination que d'origine. Les entreprises utilisant de la main d'oeuvre détachée réduisent leur utilisation de travail domestique, et payent ces nouveaux travailleurs à des niveaux inférieurs à ceux de leurs travailleurs domestiques. Dans les pays d'origine, les entreprises accédant aux marchés étrangers grâce au détachement augmentent leur profit de manière substantielle, ce qui génère des revenus supplémentaires pour les pays d'origine. Les travailleurs détachés voient leurs salaires augmenter, mais dans des proportions moindres, et ces hausses de salaires sont majoritairement expliquées par les minima salariaux des pays de destination. L'augmentation de la compétition internationale dans les services a généré des gains de pouvoir d'achat modérés pour les consommateurs européens, qui sont de l'ordre de 0.3% en moyenne.

Le second chapitre se concentre sur l'intéraction entre concurrence fiscale et flux de détachement en Europe. Lorsque l'économie est ouverte, les réponses migratoires aux différentiels de taxes se matérialisent également par le canal du commerce international de services. Ces nouvelles réponses aux différentiels de taxes via les prestations internationales de services sont quantitativement importantes. Une baisse de 1% du differentiel de taxes entre pays d'origine et de destination augmente les flux de détachement d'environ 1.1%. Ces réponses génèrent d'importantes incitations à baisser le coût du travail sur les détachés au sein des pays d'origine pour gagner en compétitivité. Ces résultats démontrent de manière directe que la compétitivité internationale n'est pas seulement une affaire de productivité mais est aussi affectée par la compétition fiscale et sociale entre différents pays. Réduire les différentiels de taxes s'appliquant actuellement aux travailleurs détachés réduiraient les flux de détachement en Europe d'environ 30%, et ces effets seraient concentrés sur les exportations de services des pays à bas coûts.

Le troisième chapitre cherche à éclairer les réponses migratoires aux différentiels de taxes sur le revenu des contribuables Européens les plus riches. En s'appuyant sur de nouvelles données, les résultats de ce chapitre démontrent que les plus aisés en Europe choisissent leur résidence fiscale en fonction des taux de taxation sur le revenu. Les réponses migratoires des riches aux différentiels de taxes sont importantes pour les étrangers, et plus modérées pour les domestiques. En moyenne, une hausse de 10% du taux supérieur d'imposition sur le revenu dans un pays entraine une baisse d'environ 2% du nombre de contribuables aisés via la migration internationale. Ces réponses sont hétérogènes au sein des Etats Membres, menant à différentes incitations à mettre en place des politiques de moins-disant fiscal. Certains pays comme la Suisse ou le Luxembourg sont plus exposés aux menaces d'émigration de leur résidents les plus fortunés, alors que des pays comme l'Allemagne ont des bases taxables moins mobiles.

Le dernier chapitre estime les effets de perte de bien-être de la compétition fiscale pour les citoyens européens. Un modèle de taxation optimale avec deux pays symmétriques est utilisé pour démontrer de manière transparente les contraintes pesant sur le système d'imposition en économie ouverte. Dans une union intégrée sans coopération fiscale, une hausse du taux de taxes entraine une hausse de l'émigration des contribuables assujettis à cet impôt (proportionnelle à leur propensité à migrer en réponse aux taxes) ce qui réduit les recettes fiscales en haut de la distribution par rapport à une économie fermée. La hausse du taux de taxation génère également une hausse de l'immigration des contribuables les plus pauvres (proportionnelle à leur propensité à migrer en réponse aux transferts) ce qui décroit la redistribution par tête en comparaison à une économie fermée. La calibration de ce modèle de taxation optimale permet de quantifier les effets de bien-être de la compétition fiscale à chaque niveau de la distribution. Les résultats montrent que la concurrence fiscale entraine des pertes de bien-être substantielles pour les citoyens européens dans la moitié inférieure de la distribution des revenus, même quand les réponses migratoires aux taxes sont faibles, qui sont de l'ordre de 10% en moyenne.

Chapter 1

Trading-Non-Tradables: The Implications of Europe's Job Posting Policy

About 7.6 million American worked in construction (...) their jobs were not in danger of moving offshore. (You can't hammer a nail over the Internet.).

— Alan S. Blinder in "Offshoring: The New Industrial Revolution", Foreign Affairs (2006)

1.1 Introduction

Because *tradable* goods or services have traditionally been defined as produced in one country and consumed in another (Grossman and Rossi-Hansberg (2008), Blinder and Krueger (2013)), controversies surrounding winners and losers from globalization have so far focused on manufacturing (factories moving to China) or intangible services (call centers moving to India). Most workers in advanced economies, however, are employed in *non-tradable* industries, which consist of services provided locally. These drivers, caregivers, or plumbers are often considered sheltered from direct import competition, unlike manufacturing laborers (Autor, Dorn, and Hanson (2013)). Conversely, operating under the premise that firms in these sectors cannot access foreign markets, the analysis of export opportunities generally focuses on manufacturing businesses (Bernard, Jensen, Redding, and Schott (2007)).

This paper challenges this assumption by showing that non-tradable jobs can be offshored "on-site", as novel trade policies allow foreign firms to perform services in the country of the customer's residence. Exploiting the largest episode to date of trade liberalization in services, the European *posting* policy, I assess the implications of opening novel sectors to international competition for workers, firms, and consumers.

Posting was first introduced in the European Union (EU) in 1959, and broadly consists of temporary contracts performed locally by foreign firms. Under the posting policy, a firm located in France is allowed to subcontract a job to a firm located in Poland. Posted workers stay formally employed by the Polish (sending) firm but cross the border to perform the activity at the French (receiving) establishment. Unlike standard trade, the service exported by Poland is produced on France's territory. Unlike standard migrants, posted workers are paid by the Polish firm and have no employment contract in France.

These novel offshoring transactions, that depart from canonical models of trade and migration, are quantitatively large, and increased dramatically over the past decade. Services exported through posted workers currently represent 30% of service offshoring in the EU, or 2% of EU GDP, while the number of workers posted abroad by service suppliers each year is *twice* as large as the number of within-EU migrants.[1] Posting flows within the EU have doubled since 2005, and grew even more in some destination markets: for instance, the number of service contracts performed by posted workers in France was 8,000 in 2000, but more than 600,000 in 2018.

As the share of manufacturing in developed economies is shrinking while employment in services rises, many recent trade agreements, from the Asia Pacific Economic Cooperation (APEC) to U.S.-Mexico-Canada Agreement (USMCA), have proposed to liberalize posting as a way to pursue international integration, following the EU example.[2] Potentially, posting policies could allow receiving firms to access cheaper labor, sending firms to access new markets, and posted workers to benefit from higher wages. However, mounting protests from local workers and governments in receiving countries suggest the alleged benefits of these policies may not be uniformly shared.[3] Against this backdrop, the lack of reliable data on service flows has been an obstacle to the assessment of the welfare impacts of these policies.

I fill this gap by gathering novel social security information on workers posted abroad. To track the cross-border provision of services in Europe, I collect exhaustive social security posting forms aggregated at the bilateral level for all EU countries. To measure granular exposure of workers and firms to posting, I further assemble novel administrative registries on posted workers. In two major receiving countries (France and Belgium), I use exhaustive linked employer-employee data merged with information on a firm's use of posted workers. In two major sending countries (Luxembourg and Portugal), I use granular firm-level tax returns merged with information on the provision of posting services abroad.

Armed with these novel datasets, I answer four fundamental questions raised by this growing offshoring channel: (i) are firms and workers more exposed to globalization when services can be offshored "on-site"? (ii) in receiving countries, are domestic employees displaced by posted workers, and what are the gains derived by receiving firms? (iii) in sending countries, how much do firms and workers gain when accessing

[1] See Eurostat statistics on within-EU trade in services (balance of payment definition), and the European Commission (2018) report on international mobility.

[2] For the U.S, see for instance recent USMCA negotiations regarding the list of occupations for foreign employees allowed to temporarily enter in the U.S to provide services "on-site" or Yost (1996) for an early discussion on the scope for posting policies under the NAFTA. Posting policies have been recently implemented in ECOWAS, APEC or in Argentina-Chile bilateral agreeement (see IACML (2015), p.22 for a debate on posted workers in Argentina). Worldwide, posting policies liberalize "mode 4 supply of services" in the WTO framework and are part of the general commitments for the trade liberalization in services in GATS. In the words of Lakshmi Puri, the Head of the UN trade in goods, services and commodities division, "Mode 4 is an area where developing countries stand to make clear gains (...) progress on mode 4 in the the GATS would allow developing countries to exploit their natural comparative advantages in international trade, including in labour as a factor of production.".

[3] For instance, see protests against posted workers in the German meat processing industry. In the past, the fear of competition through the posting policy led French voters to reject the European Constitution in 2005 (Perrineau (2005)). More recently, conflicts regarding the posting policy led to a political crisis in Europe, as Emmanuel Macron has put reforming the policy high on the EU's agenda, while Eastern and Southern European countries abstained over concerns that these reforms would hurt some of their industries.

foreign markets through posting? (iv) overall, are there aggregate efficiency gains from allowing firms to offshore formerly "non-tradable" jobs through new generation trade agreements?

The first finding of my paper is that non-tradable services are effectively traded in substantial amounts through posted workers, making firm and worker exposure to globalization broader than previously thought. I start by showing that the liberalization of the posting policy to low-wage Eastern European countries between 2004 and 2013 permanently increased the offshoring of services within the EU. Exploiting the differential timing of liberalization across country pairs and a dynamic difference-in-differences model, I evidence that posting flows in affected country pairs increase immediately by 500% in the year of the liberalization event, without crowding-out standard migration. Services exported through posted workers are predominantly supplied by low-wage countries and almost exclusively imported by high-wage countries. Posting occurs in sectors commonly insulated from international trade, such as construction, cleaning or truck driving, and consists mostly of manual service tasks performed by blue-collar workers. In sending countries, firms in "non-tradable" sectors, such as temporary employment agencies or construction firms, export as much as commonly studied exporters, such as wine manufacturers or programmers.

The second finding is that the trade liberalization in services had negative employment effects for exposed workers in receiving countries. To estimate the effect of the posting policy on domestic employment, I combine the large and permanent supply shock caused by the liberalization of the policy to low-cost suppliers with French administrative data on posting inflows at the local and sectoral level. I start with a difference-in-differences strategy, exploiting the heterogeneity in French provinces' exposure to the liberalization of posting, predicted by their spatial exposure to the posting scheme *before* the reform. While following parallel trends during the ten years preceding the reform, exposed domestic employment in high exposure provinces decreases differentially by 6% after the liberalization compared to labor markets less exposed to the shock. I estimate that moving from the 25th to the 75th decile of exposure to the supply-driven component of posting inflows after the reform decreases the share of working age population employed in exposed sectors by 0.8 percentage points. I find no evidence that workers differentially migrated away from exposed provinces after the liberalization. Domestic employment in occupations sheltered from posting competition did not evolve differentially after the import shock, suggesting displacement effects in exposed industries were not followed by a large reallocation of domestic workers within affected provinces. Unemployment remains higher in provinces more exposed to the shock, but this increase is only half the total employment effects, suggesting that part of adjustment to trade-in-services shocks occur through the margin of labor force participation.

I explain these market-level employment effects in exposed industries by two main mechanisms at the receiving-firm level. I first investigate the evolution of domestic employment at firms that offshore services through posting. Using an event study design comparing firms that start purchasing posting services to firms that are yet to offshore, I show that receiving firms significantly scale down their domestic employment when they start outsourcing tasks to posted employees. Those effects are exclusively driven by offshored tasks that are similar to those performed by domestic workers at the receiving firm, suggesting that posted workers can be used as substitutes for domestic, blue collar workers. While domestic firms decrease their use of domestic workers permanently after subcontracting jobs to posted workers, they grow in total, and remain 7% larger after using posted workers for the first time.

I then show that displacement effects can also be rationalized by receiving firms lowering labor costs through the use of posting services. While administrative measures of inputs and outputs' prices at offshoring firms are usually hard to come by, payroll tax data allow me to compare wages of domestic and posted workers. I first show that firms using posting services are those initially paying a higher wage premium to their domestic employees, consistent with cost-saving motives of posting. Posted workers are paid 30% less than comparable domestic incumbent workers at the same workplace, a wage penalty twice larger than for domestic temporary agency workers, suggesting that the posting policy was used by high-wage firms to economize on labor costs.[4] I then show that the pass-through of regular firm fixed effects in wages to posted workers is almost nil, with an estimated elasticity of 0.1 (0.01), evidencing that posted workers are cheaper due to lower bargaining power compared to domestic workers hired at the same workplace.

The third finding is that the posting policy triggered large but unequally distributed economic gains in sending countries. Availing myself of granular firm-level data from a major sending country, Portugal, I use an event study design comparing firms posting services abroad to either matched control firms in sectors without posting opportunities, or to future posting firms. Firms undergo a significant scale-up in their activity once they access foreign markets through posting, with turnover, employment, wages, profits, and cash balances rising immediately after they start providing non-tradable services abroad. The large export-mobility surplus is unequally shared between workers and capital-owners: profits increase by 37% after a posting event, while wages rise by 14%. The posting policy generates a positive fiscal externality for sending governments: sending firms pay more social security contributions and corporate taxes when they start supplying services abroad. Given the size of the export-mobility opportunities opened by the posting policy, low-wage countries with a competitive advantage in services have large incentives to lift barriers to cross-border provision of services. Interestingly, posted workers' wage gains are entirely accounted for by destination-level minimum legal wages rather than surplus sharing at sending firms.

To gauge the magnitude of the export gains triggered by trade liberalization in services, as compared to standard trade in goods liberalization, I repeat the analysis for manufacturing exporters in the same dataset. I find that gains from posting opportunities are of similar magnitude to gains from exports of goods, the usual focus of industrial policy. However, their incidence is substantially different, distinguishing the redistributive implications of posting policies from traditional trade instruments. Firms benefitting from the novel integration channel induced by posting are significantly smaller, younger, less capital intensive, and less profitable, than manufacturing exporters. While manufacturing firms benefit from permanent effects of international intregration through exports (De Loecker (2007), Atkin, Khandelwal, and Osman (2017)) or supply chains integration (Alfaro-Ureña, Manelici, and Vasquez (2019)), I show that sales growth among services exporters does not last beyond the end of the posting mission, and there is no long-lasting effect

[4] This finding holds after controlling for workers' permanent characteristics, as workplace premia for posted workers at receiving firms are 53% lower than for domestic employees.

on investment or profitability. My results thus suggest that services are characterized by weaker scope for productivity gains and "learning by exporting" than standard manufacturing.

Finally, I quantify the efficiency gains from new generation trade agreements in services. To this end, I calibrate a model building on Eaton and Kortum (2002) and Arkolakis, Costinot, and Rodríguez-Clare (2012), where manual services can be traded through posting. I seek to quantify what gains can consumers hope from increasing international competition in services through posting policies, the general motivation for those policies in the first place. While reduced-form analysis by design fails to capture general equilibrium effects of the trade-immigration liberalization, the structure of my model allows me to get to those efficiency effects.

I consider the liberalization of the posting policy to low-wage countries as my main experiment. The model yields a tractable formula to measure changes in real wages from the trade liberalization in services, accounting for general equilibrium effects in the service sector. Applying the Dekle, Eaton, and Kortum (2008) "exact hat algebra" to my set-up, welfare effects can be obtained from current posting service flows, the elasticity of these flows, and a measure of the liberalization shock. I observe the first empirical moment, and identify the other two fundamental parameters with policy variations. Using the structure of the model and these estimates, I can convert the reduced-form effect of the liberalization shock into the structural policy shock needed for the counterfactual analysis. The liberalization shock, or decrease in trade costs of services for low-wage countries, acts as a positive productivity shock in the model, allowing all countries to source services from newly available suppliers. My calibration shows that after accounting for general equilibrium effects, liberalization increased welfare for consumers of services by 0.3% on average in Europe. This effect masks heterogeneous gains: sending low-wage countries such as Slovenia, Croatia, or Slovakia emerge as the main winners of the liberalization, while countries such as France or the Netherlands derived much smaller gains. While the finding of small aggregate consumer gains from trade liberalization is close to what has been found for manufacturing, it is explained by two countervailing forces. On the one hand, posting services represent a small share of the overall expenditures of European consumers, as compared to imported goods. This small "share effect" is however counterbalanced by a much more limited substitutability of foreign and domestic services relative to standard traded goods.

This paper relates to several strands of research. First, it expands the standard concept of offshorability usually based on job's requirement of face-to-face contact and geographic proximity (Helpman and Krugman (1985), Blinder (2006), Grossman and Rossi-Hansberg (2008), Blinder and Krueger (2013), Goos et al. (2014), Jensen et al. (2005)).[5] I show that posting policies lead the scope of globalization to be substantially larger than previously thought.[6] This paper thus provides an empirical counterpart to Saint-Paul (2007), who theoretically studies the political economy of trade policies widening the range of tradability. By doc-

[5] To measure the extent of services tradability, Jensen et al. (2005) for instance look at the geographic concentration of service activities in the United States to identify industries and occupations that appear to be traded domestically. The intuition follows Helpman and Krugman (1985), where the production of non-tradable services should be distributed equally across space as compared to tradable goods. Based on geographic concentration in the U.S, Jensen et al. (2005) find that occupations in construction, maintenance or transport appear as the least tradable services, contrary to what is observed in the novel datasets on posting flows.

[6] I this contribute to the literature on complementarity between migration and trade, starting from Mundell (1957). Recently, Caliendo, Opromolla, Parro, and Sforza (2017) consider the joint effect of trade and migration liberalization on overall welfare in Europe.

umenting the magnitude and consequences of a new type of trade agreements in services (or mode 4 of service supply in the WTO classification), my paper complements the theoretical literature on trade agreements in services (Francois and Hoekman (2010), Antràs and Staiger (2012), Staiger and Sykes (2021)) or non-tariffs trade instruments (Grossman et al. (2021)).[7] On the empirical side, recent papers have assessed the magnitude of international integration in Europe (Dorn and Zweimuller (2021), Head and Mayer (2021)). My findings emphasize that posting flows must be integrated to more standard measures of international trade and migration to measure globalization accurately. Identifying trade in services through payroll tax information on posted workers, my research also fills a major gap on the measurement of trade in services at the micro level (Francois and Hoekman (2010)).[8]

Second, my paper provides novel evidence on the labor market effects of immigration, trade and outsourcing. A large literature studies the effects of immigration on domestic workers' employment and earnings, establishing that displacement and wage effects tend to be moderate or non-existent (Butcher and Card (1991), Ottaviano and Peri (2012)).[9] In contrast, the surging literature on local labor market exposure to import competition finds that manufacturing employment is heavily affected by foreign competition (Autor et al. (2013), Autor et al. (2014), Choi, Kuziemko, Washington, and Wright (2021)), and that the reallocation of workers following trade shocks can be slow (see Dix-Carneiro (2014), Kambourov (2009) or Dix-Carneiro and Kovak (2019) for instance). Liu and Trefler (2019) also investigate the occupation-level effects of services offshoring and inshoring between the US and China and India and find small effects in a context where trade in services mostly consists of services exchanged electronically. A substantial amount of work has investigated firm-level effects of offshoring practices in both manufacturing (Bernard et al. (2020), Hummels et al. (2014)) or tradable services (Crino (2010),Becker et al. (2013),Eppinger (2019)).[10] A nascent and growing literature finally studies the outsourcing of tasks to (domestic) temporary employment agencies and finds substantial negative wage effects for outsourced workers (Bilal and Lhuillier (2020), Drenik et al. (2020), Goldschmidt and Schmieder (2017)). Bringing these four bodies of research together, I show that the trade-migration flows triggered by the liberalization of trade in services impose large adjustment costs on domestic, blue-collar employment, both at the industry and receiving-firm level. Similar to what has been found for manufacturing imports, trade shocks for "on-site" services are not followed by a smooth reallocation of domestic workers across sectors, and have long-lasting effects on exposed labor markets. Similar to the mechanisms at play with standard outsourcing, "trading non-tradables" partially works by eroding the wage premium of workers in high-wage countries and firms through the use of foreign suppliers of

[7] Staiger and Sykes (2021) provide a recent characterization of trade agreements in services by mostly focusing on trade in services through commercial presence abroad (mode 3 supply of services under the WTO general classification). Those service flows are not accounted for in the standard balance of payment measures of service trade because they occur through FDI and the transaction doest not "cross the border".

[8] By assembling novel administrative data on the posting of workers, I also relate to De Wispelaere and Pacolet (2017), De Wispelaere and Pacolet (2019), that describe the evolution of posting of workers in Europe.

[9] Dustmann et al. (2017)) find important employment effects in a context that is closer to mine: short-term workers who do not live and consume in the area.

[10] Firm-level evidence mostly focuses on the offshoring of standard "tradable" services, rather than the new form of trade through temporary migration studied in this paper. Crino (2010) focuses mostly on trade in services through electronical mean (mode 1) in the U.S and its effects on white-collar employment. Eppinger (2019) for instance focus on "tradable commercial services" offshored by Germany, mostly to high-income countries. Recently, Ariu et al. (2021) also focus on imports of mostly standard "tradable" services in Finland and find a decrease in low-skill employment at manufacturing firms.

services that pay even lower wages than domestic temporary employment agencies. My results reconcile the findings of the trade and migration literature. They evidence that when policy turns international immigration into international trade- where taxes, demand, wages and rules are all set in the origin rather than destination country- the adverse effects on local labor markets are exactly similar to the one of standard manufacturing import shocks (Autor et al. (2013), Choi et al. (2021)). This paper thus also provides an empirical validation for the recent literature focusing on the labor market effects of labor supply shocks when firms have market power (Amior and Manning (2020), Amior and Stuhler (2021)).

Third, this paper contributes to our understanding of granular gains from international integration, a topic of research usually focused on manufacturing firms (De Loecker (2007), Atkin et al. (2017) for trade, Alfaro-Ureña et al. (2019) for global value chains).[11] I show that new generation trade agreements liberalizing trade in services through temporary migration generate gains of similar magnitude to more standard integration channels for firms in sectors formerly insulated from international trade. While the firms benefitting from this novel class of trade instruments are smaller, younger and less capital intensive than standard exporters (Bernard et al. (2007)), these gains are however more temporary, suggesting that unlike manufacturing industries, non-tradable sectors exhibit a weaker scope for productivity gains. Studying wage gains for workers at firms exporting non-tradable services, my results also help to characterize the effects of trade policies for workers in exporting countries.[12] I evidence a new channel through which workers can benefit from trade liberalization: because of the unique export-migration intersection introduced by trade in non-tradables, posting policies can enforce destination-level minimum legal wages and generate direct wage gains for workers posted abroad.

Finally, I extend the "gains from trade" approach developed by the seminal paper of Arkolakis, Costinot, and Rodríguez-Clare (2012)) to service industries.[13] My results outline that the general equilibrium gains from posting policies are driven by different forces. In particular, manual services are characterized by smaller structural elasticities than imported goods (Head and Mayer (2014)), leading to different welfare implications for similar consumption shares.[14]

The rest of the paper is organized as follows. Section 2 describes the institutional framework of posting policies in the European Union and describes the data used in the analysis. Section 3 documents novel facts on exposure to globalization. Section 4 explores the consequences of posting policies for firms and workers

[11] Some studies have also emphasized the interplay between trade in services and trade in goods. Bernard and Fort (2015) for instance show that manufacturing firms in the U.S increasingly rely on imported goods while specializing in the production of new services domestically. Ariu, Mayneris, and Parenti (2020) show that the production and exports of goods and services can be complementary. As they document, the simultaneous exports of services and goods mostly concerns firms that primarily produce goods (e.g manufacturing firms). In my set-up, I find that firms exporting non-tradable services through posting policies very rarely export standard goods.

[12] See Goldberg and Pavcnik (2005) for Colombia, Facchini et al. (2019) for China or McCaig (2011) for Vietnam.

[13] A number of quantitative papers have used the reduced form effects of trade shocks to calibrate general equilibrium gains from trade accounting for distributional effects of trade exposure, such as Adao et al. (2019b), Caliendo et al. (2019) or Galle et al. (2021). These models usually combine Roy models of the labor market with a gravity model of trade to get to the distributional effects of trade shocks. More closely related to my calibrations, Hsieh and Ossa (2016) or Amiti et al. (2017) focus on the overall price effects of liberalizing trade from China.

[14] I thus contribute to the large literature on the effects of traditional trade instruments on trade flows. Francois and Hoekman (2010) stress that while the literature on standard service trade and policy is growing, there is still no evidence on cross-border services supply due to a lack of data. Assembling an array of new datasets on trade mobility flows allows me to fill this gap and to estimate the distinct responsiveness of services' trade. My estimates thus also contribute to a small but growing body of literature, recently surveyed in Kleven, Landais, Munoz, and Stantcheva (2020), that establishes that top-income workers react to taxation through international migration. I extend this result to the international mobility of blue collar workers intermediated by firms.

in receiving labor markets, and Section 5 estimates export surpluses in sending countries. Section 6 quantifies the aggregate consumer gains following the trade liberalization of services, and Section 7 concludes.

1.2 Institutional Framework and Data

1.2.1 On-Site Offshoring and New Generation Trade Agreements

This paper documents a trade mobility channel where firms' cross-border services supply relies on workers' mobility across space. Posting policies broadly consist in temporary contracts performed locally by foreign firms. To export non-tradable services, foreign suppliers temporarily send their employees abroad to perform a service mission, a phenomenon I call *cross-border provision of services* or o*n-site offshoring*. Services suppliers are not physically located in the receiving country: the service is accounted for in the sending country's production while being performed abroad.[15]

We usually describe standard international trade as an exchange of good or service that is produced in one country while being consumed in another country. Posting policies departs from the canonical conceptual framework of trade in services, where a task is produced remotely in a foreign country and is then imported by electronic means by domestic entities. Services exported through posted workers are performed by a foreign supplier *in the territory* of the domestic consumer. The services involved in these transactions cannot be exchanged by electronic means, for example, cleaning or plumbing.

The international mobility of employees triggered by trade in services is also conceptually different from standard migration. Posted workers do not change their residence country, in contrast with immigrants who integrate their receiving country's labor market.[16] Posted workers have no employment contract nor tax liability in the receiving country, while standard immigrants are hired "on-site" like other domestic workers.

Export of services through posted workers is called *mode 4 service supply* in the WTO general framework for trade in services. Posting policies regulating these novel trade-migration flows have thus been discussed in most of recent trade agreements, and are systematically negotiated in multilateral GATS (*general agreements on trade in services*). Because of the unique intersection between foreign services provision and consumer location that is absent in standard trade, posting policies imply that receiving countries choose what taxes, entry, and regulations apply to posted workers in their territory. As noted by Bhagwati et al. (2004), when trade in services was brought into the fold of international trade rules via the General Agreement on Trade in Services (GATS), trade in services through temporary migration (posting) was the most controversial. In their words, "at the time, developed countries opposed the inward movement of people through mode 4, while developing countries pushed for the liberalization of Mode 4 services, which offers

[15] A service performed by a services supplier located in country A in the territory of country B through posted workers will be accounted for in country A's GDP and exports country B's imports. It has a different incidence compared to FDI (mode 3 services supply), where foreign firms open an establishment in a receiving country. In that case, foreign establishment's sales are included in destination-level GDP, not origin-level GDP.

[16] Posted workers are therefore not accounted for in destination-level employment and economic statistics. Another difference is that posting flows are only driven by firms' transactions. Unlike standard migration, posting flows should not be explained by non-economic factors that affect permanent location choices of individuals.

their unskilled populations the possibility of offering services in developed countries."

1.2.2 The European Laboratory: Posting Policy

Established in 1959, the EU posting policy allows firms located in the territory of one member state to send their workers in any other member state to perform a temporary service mission, without having to open an establishment in that country. Posted workers can be employees posted by their permanent employer, by a temporary employment agency, or between firms of the same group. Firms are allowed to hire workers for the sole purpose of posting them; self-employed workers can also post themselves abroad.

The posting policy, described in Figure A.1, further determines what taxes and regulations apply to these novel migration trade flows in the receiving country. Receiving countries must grant large exemptions to posted workers: sending firms only have to pay payroll taxes in the sending country.[17] Posted workers are also not liable to most employment regulations in the receiving country. However, to combat social dumping and prevent distortion of competition, the EU provided posted workers with a legal right to the *basic minimum* rights and conditions in receiving countries. Since 1996, posted workers have thus benefited from destination-level minimum legal wages and maximum work durations. In receiving countries without a minimum legal wage, and for the self-employed, the prevailing minimum pay rule does not apply. Since 2020, posted workers must receive the same *pay* as domestic employees at the receiving firm and are covered by some collective labor agreements.

While the posting policy is meant to regulate "temporary" services provision between member states, there is not a legal limitation to posting mission. The sending firm must, however, have a "substantial" activity in the country of establishment. Exemptions from receiving payroll taxes are also granted for a limited duration: 12 months until 2010, 24 months from 2010-2020, and 18 months since 2020.[18] If firms located outside the EU want to provide a service in the EU, they must obtain a work authorization and temporary visa for each of their workers. In some cases, they must open an establishment in the destination country, and are not able to use cross-border provision of services.

Receiving countries have no right to refuse the foreign intervention of supplier of services in their territory, but can control that the posting mission follows the rules established by the EU posting policy.

1.2.3 Data

The lack of evidence on cross-border provision of services can be traced to the absence of reliable data to measure these novel trade-migration flows. This subsection discusses the novel administrative datasets on postings within the EU that fill this gap. Datasets are summarized in Table A.1 and Table A.2 and are described in separate data appendices.

[17] Sending firms pay the corporate income tax in the country of origin, while the VAT on the service mission is paid by the client in the receiving country.

[18] Until 2010, labor tax exemptions could be renewed without restrictions. Since 2010, these exemptions are only granted for a new posting mission if two posting periods involving the same worker, sending and receiving firms are separated by a two-month break.

A. Europe-Wide Dataset on Bilateral Posting Flows

The first dataset leveraged for the analysis builds on administrative social security certificates E101/A1 issued for each posting mission within the EU. This certificate is a mandatory document that posted workers must hold during their mission to prove their affiliation to their sending country's social security system.[19] The posting certificates are issued by sending countries and are linked to the work mission rather than to the worker: a unique worker may be linked to several posting forms. One E101/A1 form identifies simultaneously a flow of a worker moving abroad and a service mission export.

Using exhaustive information on issued posting forms by receiving countries for each sending member state each year collected from the EC, I build the full matrix of bilateral posting flows from 2005 to 2017.[20] I merge this dataset with measures of countries' wages, employment and GDP from Eurostat. The final dataset allows me to track yearly bilateral posting service flows within the EU from 2005 to 2017 with joint information on sending and receiving countries' income.[21] That dataset allows me to recover standard "gravity" information on bilateral trade-in-services in Europe, overcoming two major measurement challenges usually faced by trade economists. First, unlike for standard exports, social security forms do not have a minimum declaration threshold: I thus have limited missing flows in my dataset.[22] Second, while services' transactions are usually poorly measured due to their intangible nature, payroll tax information on posted workers helps reconstruct reliable administrative records of trade in services.

To quantify the *monetary value* of service trade through posting, I use additional data on within-EU trade in services through the posting of workers abroad collected from Eurostat for 2017.

B. Country-Level Micro Data on Posting

To measure granular exposure of firms and workers to the posting policy, I complement the EU-wide posting dataset with micro administrative data on posting in six countries.

Administrative Registries of Posted Workers in Receiving Countries Linked employer-employee data in receiving countries allow me to study the consequences of posting for domestic workers. I use administrative registries on incoming posted workers in receiving countries where these registration requirements exist: France and Belgium, which are the top second and third importers of posting services.

All firms that post their employees to France (respectively, Belgium) to perform a service are required to file a DPD/SIPSI (respectively, LIMOSA) posting declaration. If the declaration is missing, both sending and receiving firms are liable to sanctions and fines and the posting mission is interrupted. For France, I use exhaustive received posting declarations by province-year-sector from 2000 to 2015 and disaggregated

[19] The absence of the E101/A1 social security forms implies a fine for services supplier and receiving firms and can lead social security contributions to be paid in both sending and receiving countries. The E101/A1 only concerns trade-related mobility within the EU and does not apply to postings from outside the EU. As these flows are very heavily regulated, they are, however, very small, as shown in the rest of this paper.

[20] Historical data on E101/A1 forms also exist for the 1988-2000 period but are aggregated for the entire EU.

[21] To document the relationship between labor cost and posted worker flows, I also merge this dataset with measures of employers' labor cost measured by Eurostat in each member state from 2009 to 2017. The final dataset allows me to track yearly bilateral posting service flows within the EU from 2009 to 2017 with joint information on sending and receiving countries' wages, employer payroll taxes, and minimum legal wages.

[22] Silva and Tenreyro (2006) discuss the issue of missing or zero flows in standard trade datasets.

declaration data for 2017-2020. For Belgium, I use the universe of disaggregated posting declarations for 2010-2020. While the LIMOSA and DPD/SIPSI are separate datasets, they have the same structure and are based on similar declaration requirements, hence I describe them in the same section.

In each datasets in each of these two receiving countries, I use the unique receiving firm identifier to link posting registries with linked employer-employee and balance sheet administrative data on domestic workers and receiving firms.[23] I can identify which firm purchased a service performed by posted workers, which foreign supplier and posted workers performed this mission, and detailed information on the posting mission. The final merged datasets allow me to observe jointly posted and domestic workers' hours of work, tenure, wages, occupation, and demographics and to link them to their common workplace in receiving countries.[24] To summarize, I observe: (i) all local-sectoral-year inflows of posting services in France from 2000 to 2015 (ii) all granular purchases of posting services by French firms from 2017 to 2020 with detailed information on domestic, posted workers and the posting mission and (iii) all granular purchases of posting services by Belgian firms from 2010 to 2020 with detailed information on domestic, posted workers and the posting mission. The datasets are further described in the Appendix.

In Germany, all companies posting workers in the construction sector must pay a compulsory contribution to the national fund for holiday leave, SOKA-BAU. I use data provided by SOKA-BAU on the universe of workers posted to the construction sector in Germany since 2000.

In Austria, all companies that post workers in the construction sector must contribute to the national fund for holiday leave by making a payment to the national building union BUAK. I use data provided by BUAK on the universe of workers posted to the construction sector in Austria since 2006.

Administrative Registries of Posted Workers in Sending Countries Firm-level administrative data in sending countries allow me to analyse services export gains for sending firms and posted workers.

I use administrative employer-employee data on the universe of workers employed in Luxembourg merged with information on posting social security forms at the worker level for 2002-2019.[25] I observe all job spells in Luxembourg for posted and domestic workers, together with detailed information on employers, employees, and jobs characteristics, such as wages, tenure, hours of work, employer's two-digit sector code, and employee demographics. This dataset is described in the Appendix.

To obtain granular data on posting companies and their performance, I finally leverage administrative tax data on firms in Portugal, one of the top exporters of posting services. The dataset provides detailed information on firms' five-digit sector code, wages, employment, investments, sales, and other balance sheet components. Each year, firms established in Portugal report to the tax administration the amount of services performed abroad by the geographical market of destination. I use this information to identify the

[23] All domestic registries on firms and workers are listed in Table A.2 and in the Appendix. The matching procedure is described with extensive details in each separate data appendice as well.

[24] Extensive information on the posting mission include duration of the work mission, location of the work performed, and whether the foreign supplier provided food/housing to the posted workers. Posted workers' wage is only observable in the DPD/SIPSI dataset (France), as the Belgian authorities do not keep this information.

[25] Because small countries are more exposed to trade, Luxembourg has one the highest postings-to-employment ratio.

universe of Portuguese firms that supplied posting services in another EU country between 2006 and 2017.[26] The Appendix provides more detail on the dataset.

1.3 Trading Non-Tradables: Who is Getting Globalized?

In this section, I use my datasets on posting in Europe to document two core facts that motivate my analysis: (i) globalization is larger once we account for the novel trade-migration flows caused by the posting policy, and (ii) it has a radically different incidence compared to standard trade and standard migration.

1.3.1 Globalization is Larger Once Accounting For Posting Flows

A. Rethinking Standard Measures of Globalization

I start by assessing briefly the current magnitude of export of services through posted workers in Europe. Data on export of services through posted workers within the EU suggest that posting transactions are currently worth around 280 billion euros in 2017; which accounts for 27% of overall trade in services within the EU and roughly 10% of within-EU manufacturing trade (Figure 1.1, Panel A). Interestingly, these computations suggest that cross-border exchanges of services through posting of workers are as large as financial and ICT services between European countries, the usual focus of trade in service policies. Overall, these numbers suggest that almost 2% of EU GDP is additionally traded through the novel migration-trade channel opened by the posting policy.

Cross-border provision of services also affects measures of international mobility of workers. My administrative datasets allow me to compare the number of *unique* workers posted abroad with the number of *unique* working immigrants in receiving countries. Using administrative data on incoming posted workers and migrants in France, I show that incoming flows of (unique) posted workers account for almost 70% of all unique foreigners entering in the French labor market each year (Figure 1.1, Panel B). Turning to the entire EU, comparing flows of posted workers with the number of workers changing their residence country each year to work abroad, I show that trade-related mobility flows are *twice* as large as international migration flows of workers within the EU (Figure 1.2, Panel B).[27] Our standard measures of international mobility of workers and trade in factors thus appear to be severely biased downward.

B. Causal Effect of the Posting Policy on Trade-Migration Flows

After showing that the posting of workers account for a substantial share of standard international (trade and migration) flows, I turn to the causal effect of the posting policy on cross-border service trade.

I focus on the transition from quasi-autarky to full liberalization of cross-border service trade for 13 new EU member states (henceforth NMS) from 2004 onwards. Postings from non-EU to EU countries face entry

[26] The dataset also includes information on manufacturing exports, allowing me to compare non-tradable services exporters to standard manufacturing exporters.

[27] This is consistent with the lastest estimates of the European Commission (2018) report on intra-EU labor mobility that gives an estimate of 1.8 million posted workers against 1 million within-EU movers, including children, retirees, students and non-active working-age individuals.

barriers and is as regulated as in other free trade areas. When a country is an EU member, entry restrictions for its firms' employees are lifted in all other EU countries. The EU enlargements of 2004, 2007, and 2013 triggered the service trade liberalization for successively 10 (Poland, Lithuania, Hungary, Estonia, Latvia, Slovakia, Slovenia, Czech Republic, Malta, and Cyprus), 2 (Bulgaria and Romania), and 1 (Croatia) low wage countries located in Eastern Europe (Figure A.2, Panel A).[28] Different timings of the liberalization for workers posted from these countries were further allocated to different receiving countries by the EC. Austria and Germany kept the pre-enlargement entry restrictions in some sectors for the seven years that followed EU accession events.[29] All other EU countries had to grant free access to services suppliers from new member states right after each EU accession event. The timing of services' trade liberalization events is exemplified in Figure A.2, Panel B. Importantly, in most cases, the timing of posting liberalization reforms differs from the timing of standard migration liberalization for NMS.[30]

To estimate the causal effect of the posting policy, my identification strategy uses a triple differences approach where I compare posting flows from treated versus control countries before and after services' trade liberalization to countries that did or did not lift entry barriers. The origin-destination staggered dimension of these reforms allows me to effectively control for any unobserved posting determinants that vary at the country-by-year level. For instance, Poland's entry in the EU in 2004 may enhance its economic relationships with France, which could in turn increase posted worker flows from Poland to France in 2004. I control for origin-year and destination-year fixed effects to filter out these confounders.

One may be concerned that the timing of the service trade liberalization in a given origin-destination country pair is correlated with the future evolution of posting flows in that country pair after the event. For instance, if countries lifted entry restrictions right after EU accession because they expected to receive more service flows compared to countries that kept the restrictions, my estimates could be biased upward. The EC held posting restrictions in Austria and Germany because these countries were "at risk" to be heavily affected by foreign suppliers' competition from lower cost countries.[31] If any, keeping entry barriers at EU accession is correlated with expecting large posting inflows compared to other receiving countries, leading my estimates to be biased downward. The inspection of pre-trends before the event will allow me to test directly whether posting flows from treated versus control countries evolved differentially before the event. Ultimately, the inclusion of origin-year and destination-year fixed effects controls for potential demand shocks that would be simultaneously correlated with (or even cause) the decision to open labor markets to posted workers.

To observe posting flows from NMS *before* the posting policy, I use data on posting flows in receiving countries that have a country-level registration tool: France, Belgium, Austria, and Germany, that are the

[28] These 13 countries represent 20% of the current EU population.

[29] The sectors that kept posting restrictions were in Germany: construction, industrial cleaning, and interior decorators; and in Austria: horticulture, stone cutting, metal structure manufacturing, construction, security activities, industrial cleaning, home nursing, and social work

[30] For instance, France lifted entry restrictions for posted workers from NMS of 2004 in 2004, but kept entry restrictions for standard migrants until 2008. Similarly, Belgium opened its labor market to workers posted from NMS of 2004 in 2004, while migrants were only able to come in 2009. I exploit these differences to document potential substitution between posting and standard migration.

[31] The geographical proximity between Austria and Germany and the 10 new member states of 2004 was the key argument for allowing some services sectors in these receiving countries to be "protected" from the service trade liberalization at EU accession.

top four importers of posting services in EU and represent roughly 60% of all imported flows.[32] Figure 1.3 illustrates how postings from countries treated by the service trade liberalization event (red series) evolved compared to postings from countries not affected by it (blue series), before and after the reform (vertical red line). In the six country-level experiments, postings from treated and control countries do not exhibit differential trends before the reform. Panels A, C, and E show that posting flows increase immediately after mobility barriers are lifted at EU accession. In countries where restrictions are kept, no differential evolution of posting flows is observed at EU accession, while postings from treated countries start to differentially increase when regulatory entry barriers are lifted later on (Panels B, D, and F).

To pool all entry reforms, I estimate a dynamic staggered difference-in-differences model:

$$\ln S_{ijt} = \alpha_{ij} + \alpha_{jt} + \alpha_{it} + \sum_{k=\underline{c}}^{\overline{c}} \beta_k D_{ijt}^k + \varepsilon_{ijt}, \tag{1.1}$$

where S_{ijt} is the number of postings from country i to country j at time t and α_{ij} is an origin-destination fixed effect. The treatment is defined as country i gaining the right to post workers without entry restrictions to country j at time t. I define the event dummy as $\mathbb{1}.[t = d_{ij} + k]$, where d_{ij} is the year at which country j lift mobility barriers for employees sent from country i. D_{ijt}^k is equal to one for treated country pairs in year k of the liberalization event while is equal to zero for country pairs that are never or yet to be affected by a liberalization reform. Including origin-year and destination-year fixed effects controls for all time-varying factors in sending and receiving countries that affect the equilibrium level of bilateral posting flows. I normalize $\beta = -1$, set $\underline{C} = -5$ and $\overline{C} = +9$ and $D_{ijt}^{\overline{c}} = \mathbb{1}.[t = d_j \geq \overline{C}] \times \mathbb{1}.[T_i = 1]$ and $D_{ijt}^{\underline{c}} = \mathbb{1}.[t = d_j \leq \overline{C}] \times \mathbb{1}.[T_i = 1]$. I estimate Equation (1.1) using the OLS twoway fixed-effects estimator and the De Chaisemartin and d'Haultfoeuille (2019) estimator accounting for heterogeneous treatment effects. I also estimate Equation (1.1) in its multiplicative form, using a Poisson Pseudo Maximum likelihood (PPML) estimator to account for potential biases induced by the log transformation, following Silva and Tenreyro (2006).

The coefficient of interest estimated from Equation (1.1) compares postings between country pairs that are treated by a posting liberalization reform in event year k compared to postings between country pairs that are never or yet to be treated by such a reform.[33] I plot the series of estimated β_k and their 95% confidence intervals in Figure 1.4, and report the estimates in Table 1.1.

I find no evidence of differential pre-trends, which indicates that the timing of the liberalization reform is not correlated with differential evolution of postings between control and treated country pairs before mobility barriers are lifted. The Fstatistic for joint significance of treatment effects before the reform is 0.32 (p-value of 0.802). The number of workers posted from countries that benefit from the the posting liberalization reform starts to increase right after the event, indicating that the reform causally increases cross-border

[32] Unlike the A1/E101 data, country-level registration tools record postings from non-EU countries. The Appendix shows postings from new member states using the E101/A1 dataset. For Germany and Austria, I focus on postings to the construction sector (recorded in BUAK and SOKA-BAU datasets), as the liberalization only affected a subset of sectors including construction in these countries.

[33] For instance, it compares how posting flows from Poland to France evolved in 2005 (one year after the liberalization event for France-Poland) compared to the evolution that is observed the same year for postings from Spain to France (never affected by an entry liberalization reform over the estimation periods and treatment window) and from Poland to Germany (yet to be affected).

services supply. The estimated treatment effects are large and statistically significant at the 1% level. Posting flows between treated country pairs increase by 500% the year of the liberalization event relative to the year before, and the effects last permanently after the end of posting restrictions. The estimated trade-migration effects of the posting policy are unchanged by the inclusion of origin-year and destination-year fixed effects that filter out the overall effects of EU accession for NMS. Using alternative estimators accounting for heterogeneous treatment effects across events, or using the PPLM transformation, leaves the estimates unchanged. Figure 1.4 confirms that the posting policy causally affects trade-migrations flows, and that the liberalization of posting mobility from 2004 onwards dramatically increased cross-border service trade in the EU. I refer to this episode as "liberalization" in the rest of the paper.

A natural question raised by Figure 1.4 relates to crowding-out effects of the posting policy on standard migration. To understand if posting and migration flows are substitutes, I exploit the fact that most countries liberalized posting and migration flows in different years. In Figure A.5, Figure B, I estimate posting flows responses to bilateral migration reform events in place of posting reforms. Posting flows do not react to the migration reforms, suggesting posting is not used as a substitute for standard migration. Hence, baseline results are unchanged when controlling for bilateral migration reforms implemented in different years than posting reforms (Figure A.3, Panel B). That is consistent with migrants being very different in terms of characteristics compared to posted workers, as showed in Figure A.5, Panel A.[34] I further show in Figure A.3, Panel A, that the estimated effects of the liberalization reform are robust to excluding events where posting and migration liberalization occur simultaneously, confirming that the baseline results are driven by posting reforms only.

1.3.2 Novel Exposure to Globalization

Cross-border provision of services increased international trade and international mobility of workers in the European economy. The incidence of those novel flows is different compared to standard trade and standard migration: the posting policy exposes novel sectors, workers and firms to globalization.

A. Formerly Non-Tradable Jobs Become Offshored Through Posting

The posting policy is mostly used by firms to offshore services commonly sheltered from trade. Using detailed data on posting missions in France, the second importer of posting services in the EU, Figure 1.5, Panel A shows that almost 35% of the missions performed by posted workers occurs in the construction sector, 35% in manufacturing services (e.g., welding, electronic installation, or pipe-fitting), 18% in business services (e.g., driving, cleaning or food catering), and 10% in agriculture.[35] Those offshored jobs are mostly manual services: blue collar workers account for 65% of all workers posted abroad and 58% of all on-site offshored services (Figure 1.5, Panel B). Top occupations of the workers posted to France include

[34] The Appendix discusses the question of complementarity between posting and migration in more details.

[35] In comparison, construction represents roughly 7% of French domestic employment, while it is 2.5% for agriculture. The amount for overall within-EU postings based on E101/A1 forms are similar: Figure A.4 shows that construction represents more than 40% of postings in the EU but less than 10% of EU employment.

builders, plumbers, electricians, welders, pipe fitters, farm workers, mechanics, and drivers, who are typically thought as sheltered from direct import competition.[36]

The intensive use of the posting scheme observed since 2005 led to a relatively large international integration of "non-tradable" sectors within the EU compared to other areas of the world. Comparing service trade statistics within the EU and between NAFTA members, I show that in Europe, the international integration of standard "tradable" services such as finance or communication is in fact as important as international integration of locally-provided services such as construction, road transport and industrial services performed abroad. In contrast, trade in non-tradables within the NAFTA, where exports of services through posted workers are still heavily restricted, has been much lower than trade in services easily exchangeable across borders. In 2017, the gap between non-tradable services' trade and standard "tradable" services' flows was 15% in Europe, but 65% in the NAFTA. Figure A.6 emphasizes the scope for potential service trade expansion in "non-tradable" sectors following policies that liberalize posting of workers.

B. Firms Formerly Sheltered From Export Opportunities Become Exporters Through Posting

Following the different type of jobs offshored through posting, firms in sectors usually thought as "non-tradables" are in fact internationally integrated. Using detailed firm-level tax and trade data on firms located in Portugal, Figure 1.6, Panel A, shows that firms formerly sheltered from export opportunities in fact access foreign markets through posting. The share of firms in non-tradable sectors exporting services each year is large: 34% for temporary employment agencies, 29% for road transport, 15% for building completion, and 7% for residential construction. As a consequence of this large international integration of services' suppliers, cross-border provision of services represents a sizeable share of sending countries' economic activity in non-tradable sectors. The weight of non-tradable services' exports in total sectoral turnover is 28% for the road transport industry, 25% for floor covering, 19% for temporary employment agencies and 13% for painting. In contrast, exports of goods represent less than 2%, on average, of services suppliers sales, confirming that these sectors would be sheltered from export opportunities in the absence of cross-border services.

As a result, Figure 1.6, Panel B, shows that exports of residential construction and road transport services are much larger in absolute than, for instance, exports of wine (Ricardo (1891)). In the words of Grossman and Rossi-Hansberg (2006), "it's not wine for cloth anymore". But perhaps surprisingly, Portuguese drivers and builders rather than programmers have replaced wine manufacturers. Another surprising finding is that temporary employment agencies make almost as much abroad than firms specialized in computer services.

C. Workers' Usually Sheltered From International Mobility Become Mobile Through Posting

Using detailed posting data from France and Belgium, Figure A.5, Panel A, shows that posted workers are older than migrants, work more frequently in non-tradable manual jobs such as construction, originate more

[36] Note that 22% (56%) of posting contracts involve firms buying posting services in the same five-digit (two-digit) sector as their main sector. See online Appendix for additional figures on the sectoral proximity of receiving and sending firms.

from Eastern European countries, and are less likely to have a tertiary level of education, even after controlling for sending countries. Cross-border provision of services thus also exposes a different set of workers to international mobility compared to standard migration. This explains why liberalizing posting policies does not crowd-out standard immigration, as previously shown. Rather, intermediating international mobility of labor through firms may lower mobility costs and frictions, leading different type of workers to move across borders compared to our usual models of immigration.

1.4 Employment Effects of Posting Flows in Receiving Countries

I have provided substantial evidence that the posting policy increased the level of international integration in Europe and affected workers in "non-tradable" sectors. In this section, I study how posting affects receiving labor markets and domestic workers exposed to this novel form of foreign competition. I start by investigating the effects of the posting policy on domestic employment at the *market-level*, focusing on local-labor markets exposure to the posting shock. I then investigate two receiving-firm-level mechanisms that could drive these displacement effects: decrease of domestic employment at firms that use posting services, and lower prices of newly offshored inputs.

1.4.1 Effects of the Posting Policy on Local Labor Markets

To estimate the effect of the posting policy on domestic employment, this section studies local labor markets' responses to a large and exogenous shock in the supply of posting services: the liberalization of the posting policy for firms located in NMS countries that started in mid 2004 and was fully implemented in 2005. I focus on France, the second largest importer of posting services in Europe, where I am able to measure local labor markets exposure to posting with the longer time period. I observe province $\times$ sector $\times$ origin $\times$ year posting flows to France from 2005 to 2015, and region$\times$ year before that.[37] I combine the posting dataset with administrative data on employment produced by INSEE (*"emploi salarié localisé"*) that measures the number of (salaried) employees in France by year, sector, and province since 1989.[38] Importantly, posted workers are not accounted for in the French employment data, as they are employed by foreign firms and do not have an employment contract in France.

A. Identification Strategy

Identifying the effects of the supply of posting services on domestic employment is challenging because unobserved shocks could simultaneously affect demand for posted and domestic workers. Such confounding shocks would lead the estimated employment effects of the posting policy to be biased upward, e.g., would

[37] Before 2004, I can however observe sector-year level of posting exposure, which allows me to select postable or non-postable sectors. Before 2004, the design can be seen as a two-sector model, where I observe exposure to posted workers in each provinces, in postable or non-postable sectors. After 2004, I can observe sector-province-year posting flows, meaning that I can exploit within-postable sectors variations in exposure to posting.

[38] This dataset is based on micro administrative data on all employers' administrative payroll declaration in France. Due to a lack of available data on sectoral wages at the province-year level before and after the shock without a break in data serie, the local labor market analysis focuses on employment effects rather than wages.

lead to underestimating potential displacement effects from posting. To circumvent that issue, I exploit supply-driven changes in posting competition that come from different exposure to a large supply shock in posting services driven by regulatory changes. In a difference-in-differences spirit, I study the differential effect of the liberalization reform on the employment of domestic workers in sectors exposed to posting competition that are in local labor markets more or less initially exposed to the shock. It allows me to gauge the plausibility that pre-reform differences in exposure *levels* to the trade liberalization are not correlated with *changes* in the outcome of interest (domestic employment), by performing pre-trend tests as suggested by the recent literature on pre-exposure designs (Goldsmith-Pinkham et al. (2020), Borusyak et al. (2021)).

The first dimension of my identification strategy uses the large and exogenous posting supply shock that followed the opening of the French labor market to services performed by employees NMS countries in mid-2004, that was fully effective in 2005.[39] As already showed in Figure 1.3, Panel A, the liberalization led postings from NMS countries to France to increase dramatically in 2004-2005. As a result, posting exposure measured as the number of imported posting services in *total* French employment increased dramatically after 2004-2005, from 0.01% in 2000 to almost 1% in 2015 (Figure A.7, Panel A). The supply shock has been exclusively concentrated on a set of occupations (Figure A.7, Panel B). Some jobs require a set of skills, such as language, that make them hardly substitutable with posted workers. Other occupations are further covered by additional licensing for posted workers. Sectors like agriculture or construction are heavily exposed to posting competition, as they require little domestic-specific skills and sending countries are relatively well endowed in this type of labor. By contrast, other services like public administration, skilled services (accounting, administrative staff, engineering services), or health have almost zero exposure to posting. I thus focus on the effects of the shock on domestic employment in sectors experiencing a non-zero import exposure through posting.

One potential worry related to this identification strategy concerns shocks that would be simultaneous to posting openness from NMS. In practice, because the 2004 enlargement was heavily anticipated and prepared, few policy changes occured exactly in 2004 beside the expansion of the posting policy. Regarding liberalization of trade in goods, almost all bilateral tariffs between France and NMS were abolished between 1990 and 1995 and those countries progressively adopted all provisions of the "acquis communautaire" in their national law before 2004.[40] Regarding freedom of movement, most EU countries implemented safeguard clauses protecting their labor market from NMS immigrants in 2004.[41] Citizens from NMS could only enter in the French labor market in 2008, while posting of workers from NMS was fully liberalized in mid-2004. Figure A.7, Panel A, shows that immigration from NMS stayed very stable around 2004 and did not experience substantial change in trends after the 2008 liberalization. This confirms that most of exposure to international mobility of NMS workers in the French labor market came through trade in ser-

[39] Note that the French labor market opened to standard migrants from NMS-2004 only in 2008, not in 2004-2005. The "standard migration" shock is thus not simultaneous to the posting shock. I come back to this point later in the analysis.

[40] See the Accession treaty and the Europe agreements signed by each of NMS in 1990 stating the trade in goods liberalization between NMS and EU enter into force in march 1992. The reason why most of regulations and trade liberalization changes were passed before 2004 is that NMS needed to be ready to be part of EU before the date of enlargement. As a result, many reforms on capital flows were also implemented before 2004 in NMS in order to match the enlargement requirements.

[41] Those differences in the timing of liberalization for posting and immigration for the same origin and the same destination countries are used in the past section to uncover potential substitutability between immigration and posting of workers.

vices rather than standard immigration flows. To filter potential factors that would change at the same time than the posting policy, and be correlated with exposure to posting, I will control for exposure to trade and immigration shocks from NMS countries.

Measuring Local Exposure to the Liberalization Shock The second dimension of the difference-in-differences exploits large geographical heterogeneities in posting exposure that have been persistent over time. To isolate supply-driven shocks in posting exposure per worker across French provinces, I exploit pre-existing trade relationships with foreign suppliers of posting services before the reform. The intuition is that provinces located in regions with relatively more pre-exisiting relationships with suppliers of posting services should benefit more from the nation-wide supply shock of mid 2004.[42] This measure of exposure to imports of posting services is close in spirit to "enclave designs" (Card (2001)) that exploit the persistent spatial heterogeneities in immigrations flows across space. My main measure of local labor market exposure to posting import competition is pre-reform import exposure per worker in a province. Because I do not observe imports of posting services at the province but at the region level before the shock, pre-reform imports in a region are apportioned to the province according to its share of regional industry employment:

$$e^{pre}_{p\in r} = \sum_s \frac{Emp^{pre}_{p,s}}{Emp^{pre}_{r,s}} \times \frac{P^{pre}_{r,s}}{Emp^{pre}_p} \tag{1.2}$$

In this specification, $Emp^{pre}_{p,s}$ is employment of province p in the postable sectors s in 2003, $Emp^{pre}_{r,s}$ is overall employment in the postable sector s in region r the same year, and $P^{pre}_{r,s}$ measures posting flows to region r in postable industries the year before the shock. Following Autor et al. (2014) or Dustmann et al. (2017), exposure to the shock is normalized by pre-reform province's total employment. The term e^{pre}_p captures province's geographical×industrial exposure to information on posting, but is not directly linked to province-specific demand of posting services after the shock. Variations in e^{pre}_p stems from provinces being located in regions with different pre-existing posting relationships, and provinces being differentially exposed to that specific information through their pre-reform employment composition. In this set-up, and in contrast with standard "shift-share" designs, provinces with similar industry composition have differential exposure to the supply shock because they are located in regions with different pre-existing knowledge of the posting policy. The resulting pre-reform province imports of posting services per worker can be viewed as an exposure index to the liberalization reform that is constant over time, in an approach similar to Choi et al. (2021). Following Tabellini (2020) or Abramitzky et al. (2021), I can alternatively combine a province initial share of posting services with *national* sectoral shocks in posting inflows after the reform to predict exposure to posting after the reform:

$$\hat{e}^{post}_p = \sum_s s_{ps} \times \frac{\Delta P^{post}_s}{Emp^{pre}_p} \tag{1.3}$$

Where s_{ps} is the initial share of posting services in sector s performed in province p and $\Delta P^{post}_s$is the

[42] In spirit, the idea is similar to exploiting pre-exisiting trade or immigration relationship. There are 5 provinces by region on average in France. In 2003, I observe sectoral posting flows to each French region, not provinces, and thus have to allocate regional flows to each province within a region.

national average inflows of posting services in the post-liberalization period (2006-2015) in a sector s.[43] As total employment after the reform will be affected by the posting shock, I normalize those predicted flows by pre-reform total employment in the province. I use pre-reform exposure e_s^{pre} as my main exposure indicator and use predicted exposure $\hat{e}_p^{post}$ as an alternative measure of local labor market exposure to the liberalization reform.

Identifying Assumptions The identification strategy rests on two assumptions: pre-shock spatial-industrial exposure to posting (i) is correlated with imports of posting services after the shock and (ii) is not correlated with factors that would differentially affect changes in French employment in exposed sectors after the reform, in the absence of the reform.

If my strategy is similar in spirit to studies using past immigrants settlements as predictor of future inflows of workers (Card (2001), Lee et al. (2017), Abramitzky et al. (2021)), my variable of interest is imports of services. Posting inflows are exclusively driven by temporary cross-border service contracts and are therefore less likely to be explained by unobserved local factors, as compared to standard migration flows (Lewis and Peri (2015)). I am also able to observe pre-reform posting relationships in a quasi-autarky framework, where postings represent less than 0.1% of French employment before 2004. It is therefore unlikely that I will be capturing employment adjustments to pre-reform posting shocks instead of the effects of the 2004-2005 liberalization itself, a concern particularly salient in standard immigration frameworks (Jaeger et al. (2018)). Because I exploit pre-reform regional imports posting services, provinces with similar industrial composition are differentially exposed to the shock when located in regions with different initial trading networks, which also restricts worries related to cross-regional correlation in residuals across observations with similar pre-refom industry composition (Adao, Kolesár, and Morales (2019c)).

Ultimately, my set-up provides me with two major advantages for identification. First, observed data on province-level posting flows make it possible to verify that pre-existing exposure to the posting scheme is a good predictor of provinces differential exposure to the nation-wide liberalization. Figure A.8 first shows that French provinces at the top of pre-shock posting use distribution are permanently more exposed to posting inflows after the reform. Table A.6, column 1, confirms that this is the case: my baseline measure of pre-existing exposure predicts province-level posting inflows after the reform with a F-statistic of 19.49.[44]

Second, I observe differential evolution of employment in high and low exposure provinces up to 10 years before the reform. Given that my design exploits level differences in pre-existing exposure, I can assess the plausibility of the assumption that the common shock caused the change in the changes, or whether there were pre-existing differences in the changes[45]. To already address worries of spurious correlation

[43] As explained before, I observe s_{ps} for more than the two postable/non-postable sectors solely after 2004. One limitation is that province-sector initial shares in 2005 are more likely to be contaminated by endogeneity than pre-reform exposure computed before. However, as emphasized by Borusyak, Hull, and Jaravel (2021), endogenous exposure shares do not provide a threat to identification when the shocks are quasi-random, which is the case in my design as national-level inflows are driven by the liberalization of the policy (as showed in figure 1.4).

[44] The first stage of the pre-exposure variable is robust to the "delete one" sensitivity test Young (2019). The average F-statistic excluding one observation at a time is 19.3, which is very close to the baseline F-statistic for excluded instruments of 19.49 (Figure A.11). The Anderson-Rubin statistic is 15.36 and the instrument is robust to weak identification test and rejection probabilities. As emphasized by the recent contribution of Angrist and Kolesár (2021), just-identified IV are less likely to be biased and sensitive to weak IV issues.

[45] Goldsmith-Pinkham et al. (2020) emphasize the importance of relying on difference-in-differences design, when data is available,

with other local factors, Table A.5 confirms that a province exposure to pre-existing trade relationships with suppliers of services is exogenous to a province pre-reform changes in working age population (column 1), employment in exposed sectors (column 2), employment in sheltered service sectors (column 3) and unemployment rates (column 4). Provinces with different exposure to the posting scheme before the liberalization were not facing differential labor shortages in yet to be exposed sectors, nor differential demographic changes that would affect both future employment evolution and use of posting services after the reform. I also show in Table A.3 differences in pre-liberalization characteristics by exposure to posting. Provinces initially more exposed to the posting liberalization shock relied more on blue collar workers and manufacturing employment compared to less exposed provinces, albeit those differences are small, in particular for manufacturing employment. Provinces with high and low exposure to posting also had similar employment to population ratio before the liberalization. A striking feature is that more exposed provinces are disproportionately more likely to have an international border, suggesting that distance to sending countries may play in an important role in explaining local labor market exposure to the posting policy. Interestingly, more exposed provinces also had lower share of foreign born in their population. One concern is that my estimates could capture the effects of secular trends in employment that are driven by other factors than the liberalization of the posting policy and that would be correlated with some of those characteristics. For instance, if a province relies more on blue-collar workers and is also more initially exposed to the posting policy, one would be worried that I am capturing the long-term decline in blue-collar employment due to technological change rather than the effects of posting competition. To account for the fact that different pre-liberalization demographics may result in different trends in employment, my estimation strategy will flexibly control for those initial characteristics, allowing their effects to vary over time.

To test the sensitivity of my results to measures of pre-reform exposure, I use four alternative indicators of local labor market exposure to posting. I first normalize pre-reform posting inflows by 2000 total employment in a province, to alleviate worries that total employment just before the shock is more likely to be affected by it, and to avoid having the same normalization on both sides of the regression. Table A.6, column 2, confirms that pre-reform imports normalized by 2000 total employment are strong predictors of a province exposure after the reform. Second, I check that pre-reform posting flows in a region do not reflect province-specific demand shocks correlated with future evolution of exposed employment. To do so, I correct e_p^{pre} with a leave-out approach, interacting a province pre-reform industry share with regional posting flows *minus* import flows to that province.[46] Third, I use a province geographic distance to NMS countries as a measure of its exposure to the reform that is independent of past use of the posting scheme. Table A.6, column 4, and Figure A.17 confirm that French provinces located closer to countries benefitting from the liberalization experienced larger posting inflows after the liberalization. Finally, I use predicted posting imports per worker $\hat{e}_p^{post}$ computed by interacting initial posting shares with national sectoral flows. Column

to test the assumption that differences in exposure to a common shock are not correlated with future changes in the outcome of interest, in my case exposed employment. Similarly, Borusyak et al. (2021) suggest that researchers should perform "pre-trend" tests, regressing the instrument or exposure variable on lagged outcome.

[46]Formally, this alternative exposure measure is computed as $e_{p\in r}^{pre} = \sum_s \dfrac{Emp_{p,s}^{2003}}{Emp_{r,s}^{2003}} \times (P_{r,s}^{2005} - P_{p,s}^{2005})$. I use posting flows in 2005 because before, only region flows are observed, not province-level flows.

(5) shows that this alternative instrument is also a strong predictor of a province actual posting imports per workers after the reform.

Empirical Specification To obtain the differential evolution of exposed employment in high and low exposed local labor markets following the exogenous shock, I estimate the following equation:

$$Emp_{it} = \alpha + \lambda_t + \gamma_2 \mathbb{1}_{\{i=1\}} + \zeta \mathbb{1}_{\{treated_i=1\}} \times \mathbb{1}_{\{t \geq 2004\}} + u_{it}, \tag{1.4}$$

where Emp_{it} is employment in localities of type i in sectors exposed to posting competition at calendar time t, expressed either in log-level or in share of province-level working age population, and where $i = 0, 1$ is an indicator for being a top or bottom exposure locality. The interaction variable ζ captures the difference in domestic employment trends between top and bottom exposure localities after the supply shock of 2004. To obtain the dynamic effect of the liberalization on exposed employment, and to formally test for pre-trends, I also estimate the dynamic counterpart of the standard difference-in-differences specification at the province level:

$$Emp_{pt} = \alpha + \lambda_t + \lambda_p + \sum_{k=1993}^{2015} \zeta_k \mathbb{1}_{\{t=k\}} \times \mathbb{1}_{\{treated_p=1\}} + u_{pt} \tag{1.5}$$

Where Emp_{pt} is employment in sectors exposed to posting competition in province p in year t, either in log-level or in share of working age population, λ_t are calendar year fixed effects, λ_p are province fixed effects and $\mathbb{1}_{\{t=k\}}$ is an indicator equal to one in year k. I cluster the standard errors at the province level and omit ζ_{2003} such that the sequence of estimated ζ_k captures the differential evolution of employment in exposed provinces as compared to provinces less exposed to the shock in year k. To leverage the continuous measure of exposure to the shock, rather than solely comparing provinces at the top and bottom of the exposure distribution, I finally estimate a dynamic difference-in-differences model where I interact my exposure index e_p^{pre} with year fixed effects:

$$Emp_{pt} = \alpha + \lambda_t + \lambda_p + \sum_{k=1993}^{2015} \zeta_k \mathbb{1}_{\{t=k\}} \times e_p^{pre} + \lambda X_{pt} + u_{pt} \tag{1.6}$$

Where X_{pt} includes controls that vary within provinces over time. To leverage actual variations in posting exposure across provinces, I finally estimate a first difference model that correlates 2003-2015 exposed employment changes with import of posting services after the reform:

$$\Delta(Emp_{pt}) = \alpha + \zeta \Delta P_{pt} + u_{pt}, \tag{1.7}$$

In the baseline specification, ΔP_{pt} measures province inflows of posting services per worker.[47] To account for the endogeneity in imports of posting services after the reform, I use my measure of pre-reform

[47] Posting inflows are measured as the average of posting inflows over the post reform period, in pre-reform total number of workers in that province, a specification close to Dustmann et al. (2017). The exception is that my left hand side variable is not total employment, but employment in exposed sector, as in Autor, Dorn, and Hanson (2013). I also use alternative specifications normalizing post-reform inflows per 2003-2015 total employment or using the log levels of inflows instead.

exposure to an instrument for observed post-reform imports of posting services.

C. Results

Difference-in-Differences Model Figure 1.7, Panel A displays the results for the baseline difference-in-differences strategy, plotting raw means. Compared to localities that were less exposed to the shock, localities with the highest initial exposure to posting saw a decrease in the share of their population working in exposed sectors after 2004, while following remarkably similar evolution before the reform. The absence of pre-trends in the 10 years before the liberalization confirms that differences in pre-reform exposure levels do not affect changes in employment through other channels than the reform. The estimated coefficient ζ reported on the graph is negative and significant at the 1% level. The share of population working in postable employment decreased by 5.47% (1.3 percentage points) in high-exposure provinces after the posting shock compared to provinces not exposed to the posting supply shock. Repeating the difference-in-differences design using alternative thresholds for top and bottom exposure provinces yields similar changes in trends after 2004, while no pre-trends can be detected before the reform (Figure A.14).

Were these employment effects followed by reallocation of domestic workers in sheltered sectors within exposed local labor markets? If labor markets are geographically integrated and fully competitive, a shock to exposed sectors should affect the aggregate labor market through two channels: a change in employment in exposed sectors; and indirectly, through aggregate labor demand. Panel B of Figure 1.7 shows that the share of individuals working in sheltered sectors followed exactly similar trends in provinces with high and low exposure to posting before and after the posting shock. The absence of pre-trends is again reassuring, hinging on the comparability of provinces with low and high initial use of posting services. I find no statistically significant differential evolution of employment in sheltered industries following the liberalization. The large and permanent import shock in services was not followed by significant reallocation of workers to sheltered sectors within affected local labor markets.

To formally test for pre-trends and show the dynamic estimates of the average coefficient reported in Figure 1.7, Figure A.12 displays the estimated ζ_k from Equation (1.5) estimated at the province-level, controlling for province and year fixed effects. No coefficient before 2004 is significant and all coefficients prior to the liberalizaiton are close to 0 in magnitude. The F-statistic for the joint significance of pre-liberalization estimates is 1.44, with a p-value of 0.1986. Exposed employment starts to differentially decrease following the liberalization, with the effects building over time. Figure A.12, Panel B, uses the dynamic approach to relate the magnitude of estimated employment effects to intensity of exposure to the supply-driven component of posting flows. The measure of pre-reform exposure to the liberalization is remarkably related to estimated differential evolution of exposed employment after the reform. Local labor markets with the highest initial exposure to the shock face the largest employment adjustments after the reform. These effects are larger when using the bottom 20% as a control group (pink line) compared to the bottom 40% that is more exposed to posting flows (orange line). In contrast, lowering the treatment threshold to the top 20% of pre-reform exposure gives lower average employment effects.

Table 1.2, column (1), summarizes the baseline estimates of the difference-in-differences model. Each coefficient is from a separate regression. The share of working age population employed in exposed sectors decreases differentially by 1.2(.177) percentage points after 2004 in local labor markets more exposed to the shock. As employment in sheltered in sectors does not experience a change in trends after the reform, unemployment increases differentially by 5.2% in exposed provinces, emphasizing the long-lasting effects of the trade liberalization in services. Other columns of Table 1.2, Panel A, repeats the baseline estimates with alternative specifications and selection of treatment and control groups. That the estimated coefficient is similar in magnitude across different specifications underscores the stability of the statistical relationships. The results are robust to using alternative pre-reform exposure measures, such as 1990 or 2000 employment shares (column (2) and (3)), geographic distance to NMS (column (4)), region-level exposure (column (5)), or applying the leave-out correction to the baseline pre-reform exposure measure (column (6)).

To exploit all variations in provinces' pre-exisiting exposure to the reform, Figure 1.8, Panel A, plots the estimates from Equation (1.6) where the coefficient of interest is the exposure index interacted with a year dummy and the dependent variable is log employment in exposed sectors. The baseline specification only includes province and year fixed effects. The coefficients before the liberalization shock are all indistinguishable from zero and show no negative pre-trends. Starting in 2004, there is a steady decline in the event-study coefficient values, with an estimated effect of roughly -0.11 by 2015. The differential decrease in exposed employment is steep over the first years, and stabilizes after some years, suggesting that some adjustment seem to be taking place. Multiplying this coefficient by 0.51 (the average difference in exposure between the bottom 40 and top 10 decile) gives a relative decrease of 5.6 log point which is similar to the results obtained when only comparing those two groups of provinces earlier. To account for potential trends in exposed employment driven by other factors than the posting liberalization, the rest of the series flexibly control for provinces' demographics and time trends. The second serie adds the 2003 manufacturing share of province employment interacted with year fixed effects, which leaves the coefficients unchanged. The third serie adds the interaction of year fixed effects with the share of exposed sectors in total employment of a province in 2003. The fourth and fifth series respectively control for the 2003 share of blue collar workers in a province employment interacted with year fixed effects, and the 2003 share of foreign born in a province population interacted with year dummies. Even after allowing pre-reform characteristics to flexibly affect local labor market outcomes after 2004, the effects of the posting liberalization on exposed employment remains negative and significant. The relative decrease of implied by those preferred estimates is 3.2 log point, meaning that domestic employent differentially decreased by roughly 3% in more exposed local labor markets.

The bottom panel of Equation (1.6) turns to overall local labor market responses to the liberalization shock. I begin by asking whether service import shocks of the liberalization to local exposed employment cause reallocation of workers across French provinces. If the mobility response to the liberalization shock is large, it suggests that initial local impacts will rapidly spur across provinces, meaning that the indirect effects of posting on local labor markets are unlikely to be detected. The specification is analogous to the earlier model for exposed employment except that the dependent variable is the log working-age population in the province. The estimated coefficients plotted in the red series show no break in trends in 2004 and are all indistinguishable from zero. The absence of significant responses of local population size to the service liberalization shock suggests limited mobility responses of workers' to on-site offshoring exposure. One hypothese rationalizing the absence of effects is that population adjustments to local economic shocks are sluggish because mobility is costly.[48] If workers did not substantially reallocate across provinces more or less exposed to the shock, indirect effects may however occur within affected local labor markets. I then investigate the effects of the liberalization shock on employment in sectors sheltered from posting competition. The estimated coefficients show no evidence that higher exposure to the posting supply shock was associated with higher employment growth in sheltered sectors between 2004 and 2015. The absence of spillovers through higher labor demand in sheltered sectors suggests that reallocation of workers across sectors may be costly, and result in permanent employment effects in local labor markets exposed to trade in services liberalization. As a result, *total* employment decreases after the liberalization shock, as showed in Figure A.10. The coefficients become more imprecisely estimated over the more recent years, suggesting that the total differential employment losses become small in the long run.

I augment my baseline difference-in-differences results with a set of alternative specifications to test the sensitiveness of my results. First, I use an alternative measure of local exposure to posting of workers that is based on geographic distance to NMS rather than past trade relationships with those countries. I estimate equation (1.6) interacting a province (negative) total distance (in 1000km) to all NMS countries with year fixed effects and display the estimated coefficients in Figure A.9. The path of estimated effects are very similar to the baseline specification relying on pre-existing posting relationships. Employment in exposed industries evolves similarly in provinces more or less close to NMS countries until 2004 and starts to differentially decrease in provinces closer to NMS countries. Second, I augment my baseline preferred specification with a set of additional flexible controls. To check that the effects are not explained by provinces with different levels of unemployment rates before the liberalization following different employment trends after the reform even in the absence of the posting shock, Figure A.13, Panel A adds a control for pre-reform unemployment rate interacted with year fixed effects. I then verify that my baseline estimates do not merely reflect specific employment trends in border French provinces: Figure A.13, Panel B controls for time fixed effects interacted with a dummy equals to one for French provinces with an international border. Panel C of Figure A.13 further controls for pre-reform exposure to imports from China and NMS interacted with time fixed effects.[49] Panel D of Figure A.13 finally clusters the standard errors at the region level, accounting for autocorrelation of error terms, as provinces in the same region are differentially exposed to a common geographic shock. The estimated path of treatment effects are systematically similar to the baseline specification: exposed employment in more or less exposed provinces follows similar evolution before 2004, and starts to differentially decrease in provinces more exposed to the shock when posted workers from low cost countries start to gain access to the French labor market. As a final test to prove that the differential employment effects are driven by the posting supply shock, rather than simultaneous and correlated factors

[48] Those reduced-form responses of migration responses to local labor market shock do not necessarily capture the true responsiveness of individuals mobility to local demand shocks as recently emphasized by Borusyak, Dix-Carneiro, and Kovak (2022).

[49] I measure exposure to NMS (respectively China) imports through a province employment share in industries exposed to competition from those countries in 2003.

in 2004, I exploit an alternative exogenous shock in posting imports. I focus on the liberalization of posting frm Romania and Bulgaria in 2007, which first stage is exemplified in Figure 1.3, Panel C. There were less than 300 posted workers from Bulgaria and Romania before 2007, and this number increased to 3,000 in 2007 to reach more than 40,000 in 2015. To measure exogenous exposure to this specific supply shock, I use a province pre-liberalization use of posted workers from NMS of 2007. As in the "enclave" design, provinces with more posted workers from Romania and Bulgaria during the autarky period should be more exposed to the 2007 liberalization, compared to others.[50] Figure A.15 shows the evolution of exposed employment in provinces at the top and bottom of exposure to the liberalization of postings from Romania and Bulgaria, before and after 2007. While exposed employment followed similar trends before 2007, including during the period 2004-2007 when postings from NMS 2004 was liberalized, the two series start to diverge exactly in 2007. The two series are parallel after 2004, which does not mean that exposed employment does not decrease after the first supply shock of 2004, but rather than employment decreases at the same rate in those two groups of provinces. As soon as the second supply shock hits in 2007, provinces more exposed to that second shock immediately experience a differential decrease in their domestic employment. The estimated elasticity indicates a differential decrease of 4% in exposed industries and local labor market, close to the baseline result of 5.6%. This results suggests that the prime driver of the employment effects is the posting supply shock rather than simultaneous factors.

IV Model I then turn to the estimation of Equation (1.7), leveraging all variations in province's exposure to the trade liberalization in services after the reform. The top panel of Table 1.3 confirms that higher imports of posted workers after the liberalization shock is systematically associated with a differential decrease in the share of adults working in jobs exposed to posting competition. The OLS estimated coefficient from equation (1.7) is -0.638(0.231), while instrumented coefficients range from -.983(.283) to -1.604(.338). Column (2) shows the results from the reduced form specification regressing the change in exposed employment on the pre-reform exposure to the shock, which yields a negative and statistically significant estimate of -.462(.118). Across all specifications, and consistent with the difference-in-differences results, higher exposure to the supply-driven component of posting inflows after 2004 is associated with a decrease in the share of working age population employed in exposed services sectors. The baseline employment elasticity in Column (3) is -1.604(.338). Column (4) adds controls for the share of postable employment, manufacturing employment, and blue-collar employment, in a province's pre-reform employment, addressing the concern that measured posting imports per worker after 2004 is picking up overall declining trends in employment exposed to posting competition. The relationship between posting exposure and domestic employment remains economically large and statistically significant. The baseline employment effect means that moving from the 25th to the 75th percentile of exposure to the supply-driven component of posting flows is associated with a roughly 0.8 percentage point decrease in the share of working age population employed in

[50] The first-stage shows a strong correlation with pre-2007 use of posted workers from NMS2007 and imports of postings from NMS2007 after the liberalization.

sectors exposed to posting competition.[51] The effect is very close in magnitude to the comparable coefficients from the difference-in-dffferences design, reported in Table 1.2, line 2, emphasizing the robustness of the estimates to various identification strategies. Column (5) repeats the preferred specification with the full set of controls clustering standard errors at the region-level to account for spatial correlations across provinces, which leaves the interpretation of the estimates unchanged.[52]

To check that my results capture the effects of exposure to the posting shock after 2004, rather than long-run common causal factor behind both the fall in domestic employment in manual services and increasing inflows of posted workers, I conduct a falsification exercise. I regress pre-reform changes in exposed domestic employment on post-reform changes in posting inflows. Detecting a non-zero statistically significant relationship between post-reform posting inflows and lagged employment growth would raise worries that increasing service imports after 2004 is a symptom, rather than a cause, of declining domestic employment in service sectors exposed to posting competition. Column (6) shows the correlation between changes in domestic employment in the ten years preceding the liberalization and the change in service import exposure after 2004, while column (7) shows the corresponding correlation for the 2000-2003 growth. The point estimates are non-statistically significant. I cannot reject that there is no relationship between post-liberalization posting imports (instrumented with pre-reform shares) and lagged employment growth in sectors exposed to the posting competition. The estimated correlations thus provide no evidence of reverse causality, consistent with the absence of pre-trends in the difference-in-differences analysis.

In Table A.7, I augment the IV model with a set of demographic measures and alternative instrumental strategies which test robustness and potentially eliminate confounds. Column (1) repeats the baseline specification weighting the model with pre-reform employment rather than working age population, and yield a point estimate of -1.560(.299). The effects of increased posting competition on domestic employment are still negative and statistically significant when excluding industrial services potentially affected by other trade shocks (column (3)). Estimating the model with the import variable in percentage points instead of log (column (4)), or controlling for the share of foreign born in the population (column (5)) also leaves the baseline result unchanged. Column (6) tests that the effects are not driven by the normalization of the regressor by instrumenting posting inflows in levels by pre-reform posting flows, following the test suggested by Clemens and Hunt (2019).[53] Figure A.16 tests the robustness of the baseline estimate to outliers, deleting one province at a time from the regression. The estimated employment responses to posting exposure are remarkably stable to this test. Recently, Adao et al. (2019c) have also emphasized that exposure designs may suffer from cross-sectional correlations of standard errors across regions. I implement their inference procedure in table A.8 and show that the significance of the estimates is unchanged. Panel B of Table A.7 finally tests the robustness of the baseline estimate reported in column 3, Table 1.3, to alternative instruments for province's exposure to the liberalization shock. Column (7) uses the geographic distance to NMS countries that gain access to posting in 2004 as an instrument for a province imports of posting services after

[51] And that a 10% higher exposure to the supply-component of import of posting services after the reform is associated with a decrease in the share of working age population employed in exposed sectors of roughly 0.15 percentage points.

[52] There are however only 21 regions in France, which leads to a very small number of clusters.

[53] Formally, this implies to control separately for log of gross posting flows and log of initial total employment, allowing to predict only post-reform inflows of posting services by pre-reform inflows of posting services (Clemens and Hunt (2019)).

the liberalization. The effect of higher exposure to the supply-driven component of posting flows after the reform is sensibly higher than with the baseline instrument, with a point estimate of -2.192(.710). Column (8), (9) and (10) use alternative definition of pre-reform exposure to the liberalization, based on lagged industry shares or implementing the leave-out approach. The estimated coefficients are remarkably similar in magnitude, emphasizing that the baseline estimates are not explained by pre-reform differences in exposed employment shares nor by capturing demand specific shocks in the baseline pre-reform exposure measure. Column (11) finally uses predicted imports as an alternative instrument that exploits both cross-sectionnal variation in initial shares and sectoral shocks after the reform, and yields an estimated effect of -1.650(.351), again very close to the baseline estimate.

In the bottom panel of Table 1.3, I summarize the local labor market effects of the service import shocks with the IV approach. The regression specification is analogous to the earlier model for exposed employment share except that the dependent variable is the log change of the working-age population in the province (multiplied by 100). Column (9) shows no evidence that the posting liberalization shock led to significant changes in population growth between 2003 and 2015. The decrease in domestic employment in sectors exposed to posting competition should lead to an increase in non-exposed employment, unemployment, or labor force participation. Column (10) of Table 1.3 repeat the baseline specification with the log change of employment in sheltered sectors between 2003 and 2015 as the dependent variable. As in the difference-in-differences design, I find no evidence that higher exposure to the supply-driven component of posting inflows after 2004 is associated with higher employment growth in sheltered sectors between 2003 and 2015. The absence of spillovers through higher labor demand in sheltered sectors suggests that reallocation of workers across sectors is costly. That is consistent with Saint-Paul (2007) who theoretically shows that when labor markets are rigid, the backlash against trade liberalization in services will be large. The net decrease in exposed employment, and the null effect on sheltered service employment, could lead to an increase in the number of unemployed in affected provinces. Column (11) repeats the baseline specification using unemployment to population ratio as a dependent variable. That way, the coefficient reported in column (11) can be directly reported to the coeffcient on employment to population ratio reported in Column (4). The results show that the differential decrease in exposed employment does not lead to a one-for-one increase in unemployment rates. The coefficient on the unemployed to population ratio is only half the coefficient of exposed employment to population ratio. This suggests that a substantial part of the adjustment to the trade shock occurs through movements out the labor force. Exposed workers in more exposed local labor markets may for instance retire earlier, or start working later, as a response to the posting supply shock.

To summarize the results of that section, both the difference-in-differences design and the IV approach show that the trade liberalization in services led to (i) a persistent decline in the share of population working in sectors exposed to posting competition (ii) a non-significant adjustment through geographic mobility across provinces (iii) a non-significant reallocation of domestic workers from exposed to sheltered service sectors. Those results are remarkably close to the local labor market effects of standard manufacturing import shocks (Autor et al. (2013), Choi et al. (2021)), suggesting that the adverse effects of trade on workers have also been noticeable through the novel trade-migration channel. To get a sense of the magnitude of those effects, my preferred specification indicates that moving from bottom to top exposure of trade in services leads to 0.8 less job per 100 working age residents.[54] In comparison, Choi et al. (2021) find a 1.7 to 3.8 less job per working age residents when moving from less to more exposed U.S counties to a "standard" trade shock. This suggests that the overall employment effects of the posting shock on the French labor market is small in terms of magnitude, and smaller compared to import shocks that have affected other developed countries such as the U.S. While my results are close to what the literature found for trade shocks, studies on immigration shocks have more diverse results. Many studies have found limited effects of (standard) immigrants on wages and employment of natives (Card (2001), Lee et al. (2017)). On the other hand, Dustmann et al. (2017) find evidence of strong employment and wage effects on domestic workers. The context of posted workers differs from the context of standard immigration for three main reasons. First, unlike standard immigrants, posted workers do not integrate their destination labor market and are likely to have very limited positive demand effects on exposed local labor markets. Second, posted workers are employed and pay taxes in their origin country, which means that they are cheaper than domestic workers (including migrants) and that their fiscal externality (foregone taxes) is much higher compared to standard immigrants. Third, posted workers are liable to different regulations and protections compared to standard immigrants who benefit from the destination country labor code. Those three differences suggest that the posting shock is closer to a trade shock where only the "output" is imported and produced under the exporter labor market rules and prices, than to an immigration shock where foreign labor comes with its own demand and produces under the same conditions than others. Therefore, my results do not only inform the employment effects of the posting shock, but also emphasizes the implications of turning immigration shocks into a trade shocks by lowering labor regulations and taxes that apply to internationally mobile workers.

1.4.2 Receiving-Firm Level Mechanisms Driving Market-Level Employment Effects

I explain the market-level displacement effects generated by the posting policy by two main mechanisms: posted workers are substitutes for domestic workers at receiving firms, and they are cheaper.

A. Receiving-Firm Technology: Substituability Between Posted and Domestic Workers

I now try to uncover what are the receiving-firm level adjustments to the posting shock. Receiving firms could replace their own workers with posted workers, leading to negative employment effects at firms that purchase posting services. They could also simultaneously increase posted and domestic employment, for instance, if the novel source of labor allows them to be more competitive and gain market shares at the expense of their domestic competitors. In that case, one could observe a positive association between

[54] Because I observe posting contracts rather than jobs, and do not have information on number of hours worked by domestic and posted workers, computing an elasticity of domestic workers with respect to posted workers is challenging and biased by measurement errors. I perform this exercise in the firm-level analysis where I can measure hours worked by posted and domestic workers at a granular level. However a back of the envelope computation using the preferred diff-in-diff coefficient with the full set of controls suggest that on average, more exposed local labor markets had on average 3,800 less domestic jobs 10 years after the shock for 4,600 more posted workers.

using posting services and employing domestic workers at the receiving firm, while aggregate employment could still decrease at the exposed industry level. I exploit the granularity of receiving firm data to explore potential substitution or complementarity between domestic and posted workers.

I use Belgium as the main laboratory for my analysis because Belgian granular data on received posting flows have the largest time span (nine years), allowing me to exploit a large set of receiving-firm-level variations in posting exposure. Belgium is one of the top importers of posting services (third country) and shares many characteristics with most of receiving countries: it is a high-wage country with relatively high labor market regulations and uses posting services to offshore mostly manual non-tradable services. I use the LIMOSA registry on the universe of posting missions purchased by Belgian firms from 2010 to 2019, which I merge with exhaustive administrative panel on Belgian firms' domestic employment. This unique dataset allows me to identify the 17,796 unique Belgian firms that used posted workers between 2010 and 2019 and to track their employment of domestic workers over the same period.

The main identification strategy asks what happens to domestic workers when their employer starts to offshore services "on site" through posting services. I thus leverage variations in posting exposure at the *extensive margin* by focusing on firms that start purchasing posting services. More specifically, I narrow down the analysis to the 11,796 firms that purchase posting services for the first time between 2014 and 2019. That sample restriction lets me select firms that never used posted workers from 2010 to 2014 so that I can precisely measure a shift from non-using to using status. I use an event study design to estimate the differential evolution of domestic employment at Belgian receiving firms before and after they first get connected to a foreign supplier of non-tradable services. More precisely, I estimate the following specification:

$$y_{it} = \alpha_i + \lambda_{st} + \sum_{k=\underline{T}}^{\overline{T}} D_{it}^k \gamma_k + \varepsilon_{it}, \tag{1.8}$$

where y_{it} is an outcome variable for firm i (in log) in calendar year t and α_i is a firm fixed effect. λ_{sz} are three-digit sector $\times$ calendar year fixed effects. The event time dummies D_{it}^k are defined as $D_{it}^k = \mathbb{1}.[t = d_i + k]\ \forall k \in (\underline{T}, \overline{T})$, $D_{it}^{\underline{T}} = \mathbb{1}.[t \leq d_i + \underline{T}]$, and $D_{it}^{\overline{T}} = \mathbb{1}.[t \geq d_i + \overline{T}]$, where $\mathbb{1}$ is the indicator function and d_i is the first year when firm i starts using posting workers. I normalize $\theta_{-1} = 0$ and set $\underline{T} = -5$ and $\overline{T} = +5$, and I cluster standard errors at the province$\times$ event time level to account for spatial correlation in error terms, as in Alfaro-Ureña, Manelici, and Vasquez (2019). The binning of event time coefficients at the ends of the event window allows me to introduce both year and firm fixed effects to circumvent the issues related to event studies in the absence of a pure control group, following the recent econometric literature on event studies (Borusyak and Jaravel (2017), Schmidheiny and Siegloch (2019)).

The sequence of coefficients γ_k describes the dynamic of receiving firms' outcomes around the event of first services being offshored to posted workers. By exclusively comparing firms that will use posted workers at some point between 2014 and 2019, the event study design rules out any selection issue related to the "importer premium."[55] Estimated γ_k compare the outcomes of receiving firms in event year k to the outcomes of future receiving firms in the same narrowly defined sector in the year before their offshoring

[55]Firms that use posting services tend to be larger and pay higher wages compared to firms that do not, as showed in the Appendix
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event. I estimate Equation (1.8) with both OLS two-way fixed effects and an alternative estimator that accounts for heterogeneous treatment effects and negative weighting in event-study designs developed by Borusyak and Jaravel (2017).

When estimating γ_k, my goal is to identify potential substitution or complementarity between posted workers and domestic workers in receiving firms' production function. A firm's decision to purchase posting services is endogenous and plausibly correlated with time-varying unobserved shocks that are likely to also affect its domestic employment. Demand shocks experienced by the Belgian firm are particularly likely to be correlated with both decisions to hire posted workers and domestic workers. In that case, the estimates of γ_k are biased upward and underestimate potential substitution between domestic and posted workers. The inspection of pre-trends will first allow me to check whether receiving firms self-select into purchasing posting services based on past domestic employment evolution. However, the absence of pre-trends does not rule-out firm-level shocks that are both correlated with the outsourcing of services to posted workers and firm-level employment of domestic workers. I then exploit additional variations in posting exposure within receiving firms to make progress on the causal interpretation of the estimates. Ultimately, the estimates of γ_k can be viewed as a way to identify how domestic and foreign employment co-move at receiving firms after a given shock shedding-light on complementarity of substituability between these two sources of labor. Assuming that receiving firms face a given endogeneous shock, such as a positive demand shock, the event-study estimates still reflect how receiving firms structure their employment responses to that shock when they can source services to foreign suppliers.

Figure 1.9, Panel A displays the estimates of γ_k and their 95% confidence intervals using log firm total domestic employment (blue line) as the main outcome. I find that employment of Belgian workers decreases at Belgian firms that start sourcing services to posted workers. Domestic employment decreases by 2% the year firms start subcontracting services to posted workers, compared to firms in the same three-digit sector that are yet to use posting services that same year. This negative employment effect corresponds, on average, to two less domestic jobs at receiving firms for an average subcontracting of six posted worker jobs at receiving firms that year. The response of employment is amplified over time, with a 17% decrease in domestic employment four years after the first on-site offshoring event. That result suggests domestic firms substitute domestic with posted workers once they get connected to a foreign services supplier. Domestic employment in firms that use and are yet to use posted workers appear to evolve similarly before the event, conditional on firm and three-digit sector $\times$ year fixed effects. Posting use by receiving firms does not seem to be driven or caused by a differential evolution of domestic labor availability at receiving firms. The results are unchanged when estimating the event study model with the Borusyak and Jaravel (2017) estimator that corrects for negative weighting issues (Figure A.21).

Do receiving firms scale-up when starting to offshore services, or do they substitute domestic for posted workers, keeping their overall activity constant? I find that receiving firms grow in terms of *overall* size once they start using posted workers, relative to their employment level in pre-event year, but this effect gradually fades-away. Figure 1.9, Panel B shows that total employment at receiving firms, including posted workers, increases by almost 50% after the first on-site offshoring event. However, as domestic workers get progressively displaced, the overall size of receiving firms gradually gets closer to its pre-event level. Four years after first posting use, overall employment at receiving firms is only 7% higher relative to the pre-event level, while domestic employment has decreased by 17%.

If Belgian firms decrease domestic employment when starting to rely on posted workers, how are the wages of remaining workers affected? Figure 1.9, Panel A orange line shows the event study estimates using log average wage paid at receiving firms. There is no evidence that firms that start purchasing posting services change their domestic pay policy, suggesting that when gaining access to alternative workers, receiving firms adjust their domestic payroll through employment rather than wages, which is consistent with the presence of downward rigidities on domestic workers wages.

While Figure 1.9 shows evidence of domestic employment losses simultaneous to a change in posting exposure at the extensive margin, the displacement effects could be caused by unobserved shocks affecting receiving firms the year they start posting workers abroad. To make progress on that issue, I start by leveraging additional variation in posting exposure within and across firms. I first investigate whether workers who are more or less substitutable with posted workers experience similar employment losses following a posting exposure event. Posted workers are mostly blue collar and are therefore more likely to be substitutes for domestic blue collar workers. While all workers at a receiving firm should be affected by firm-level shocks, only blue collar workers should be replaced by posted workers. If the overall employment responses displayed in Figure 1.9, Panel A reflect the effects of a firm-level shock rather than posting use, we should, however, detect strong employment responses of non-blue collar employment around the posting event.

Figure A.18 shows that the domestic employment responses to posting exposure are driven by a decrease in receiving firms' blue collar employment. In contrast, I do not find evidence of any statistically significant differential evolution of non-blue collar workers after their employer starts purchasing posting services. It suggests that the overall displacement effects experienced by domestic workers at receiving firms are driven by substitution between domestic and posted blue collar workers rather than by simultaneous firm-level shocks that would also affect white collar employment at these firms. As a result, aggregate domestic blue collar employment at Belgian firms offshoring services to posted workers has decreased substantially over the past 10 years. Figure A.19 shows that the share of blue collar workers at Belgian firms using posting services at least once between 2010 and 2019 started to decrease in 2010, decreasing from 58% to 54% between 2009 and 2019. At the same time, posting exposure increased dramatically: the share of posted workers in total workers hired at firms purchasing posting services once during the period increased from 5% to 16% between 2010 and 2019.

One other source of heterogeneity regarding the intensity of exposure to posting across workers lies in the proximity between the offshored service and the type of job performed by domestic workers. Two Belgian firms offshoring a construction service to a foreign firm may be affected by similar unobserved demand shocks or other factors correlated with the decision to use a foreign service. However, only receiving firms also operating in the construction industry should substitute their own workers with posted workers. I show in Figure A.20 that the domestic employment losses at receiving firms are driven by firms that offshore tasks close to their own activity. While construction firms decrease their domestic workforce once they start using construction work performed by posted workers, manufacturing firms do not significantly change their domestic employment after they start offshoring construction services to posting firms. It confirms that the estimated displacement effects at receiving are plausibly driven by substitution between domestic and posted workers rather than other simultaneous shocks.

B. Receiving-Firm Inputs Cost: Wages of Posted and Domestic Workers

Did the posting policy allow receiving firms to access cheaper inputs when substituting posted for domestic workers? While it is usually impossible to observe prices of domestic and foreign inputs at offshoring firms, my datasets allow me to compare posted and domestic workers' wages at the same workplace. I take advantage of unique matched employer-employee data on the universe of job spells in France for 2017-208 (DADS) that I match with the universe of posting contracts for the same period (DPD/SIPSI dataset).[56] I use the French-level data, rather than the Belgian receiving-firm-level data, because only the French data have information on wages paid to posted workers. I start from the universe of posting missions declared to the French authorities in 2017 and 2018 to track back the 19,138 French clients that have purchased a posting service at some point in that period and appear in the linked employer-employee dataset.[57]

Standard cost-saving theories would advocate that firms using posted workers are also firms that have higher domestic wage premia, as is the case for standard outsourcing (Bilal and Lhuillier (2020)). To test the hypothesis, I first estimate the importer wage premium: firms that offshore services "on site" pay domestic wages that are, on average, 20% higher than firms that do not use posting services in the same five-digit sector.[58] Such importer premium could, however, reflect firms' selection into on-site offshoring rather than true differences in pay policies at receiving firms. To better understand whether pay policies differ between firms that use or do not use posting services, I estimate the firm-level wage premium based on the workhorse Abowd et al. (1999) (henceforth AKM) model. Formally, I estimate the following specification on the universe of domestic job spells:

$$\ln w_{it} = \alpha_i + \psi_{J_i,t} + \beta X_{it} + +\epsilon_{it}, \tag{1.9}$$

where α_i are worker fixed effects, $\psi_{J_i,t}$ are J workplace effects, and X_{it} are worker characteristics (cubic age and number of hours worked). I estimate Equation (1.9) using the methodology developed by Correia (2017) and cluster standard errors at the worker level.[59] The wage changes of domestic workers moving

[56] The dataset is described in detail in Appendix. I merge the DADS (matched employer-employee dataset on all job spells in France) with the SIPSI dataset that records all posting missions performed in France with information on the using French firm ID (SIREN). Since DADS allows me to follow individuals only from one year to the next, the analysis focuses on postings in 2017 and 2018.

[57] There are 23,332 unique French firms with a national identifier number (SIREN) that can be identified as purchasing posting services in 2017 and 2018. Of these firms, 19,138 have at least one employment spell in the linked employer-employee dataset DADS that records all job spells in France.

[58] Results are displayed in the Appendix . Following Bernard et al. (2007) for importers, I regress firms' outcomes on a dummy equal to one if this firm is using a posting service that year, controlling for industry and province fixed effects. Compared to companies that do not use posted workers, firms sourcing their services on site through posting are larger in terms of sales and employment. They also exhibit more capital per worker and are more profitable. These findings are in line with Bernard et al. (2007), Fort (2017) or Antras, Fort, and Tintelnot (2017), who report that US importers exhibit a size premium. Reproducing their analyses for non-tradable imports in France, I show in Appendix that the size premium of receiving firms increases with the number of countries from which a firm sources its posting services. This suggests that as for standard importing, "on-site offshoring" is constrained by important country-level fixed costs of sourcing that limit the ability of small firms to source posting services from a large number of countries.

[59] Due to computational issues, I select a random sample of 20% of firms that are never observed as purchasing posting services

between different workplaces identify the fixed effects in a connected set. I plot in Figure 1.10, Panel A the distribution of firms fixed effects separately for receiving and never-receiving firms. Pay policies at receiving firms are shifted upward, indicating firms that pay high-wage premia to their domestic workers tend to use more "on-site" foreign services, consistent with the hypothesis that high-wage firms are more likely to use posting services to save on high-wage premia. The mean receiving firm wage premium is 0.18 relative to the mean wage premium of non-receiving firms normalized to zero.

If the use of posting services is explained by cost-saving motives, receiving firms may be able to pay these workers at lower wages than their in-house workers due to lower rent-sharing associated with alternative work arrangements (Katz and Krueger (2019)). I then turn to the second hypothesis: workers hired through posting arrangements are cheaper than domestic workers. I begin by estimating the raw wage penalty associated with posting arrangements in the sample of receiving firms based on the following specification:

$$\ln w_{it} = \rho \times Posting_{it} + \psi_{J_i,t} + \beta X_{it} + \epsilon_{it}. \tag{1.10}$$

Equation (1.10) allows me to compare wages of domestic and posted workers who perform work at the same firm. As posted workers do not transition from posting to regular work arrangements, it is not possible to separately identify the posting fixed effect when including a worker fixed effect. However, I control for work duration, age, and age squared to partially absorb potential differences in work arrangements. The results reported in Table 1.5 show that workers with similar age and work duration at the same workplace are paid 30% less when hired through a posting contract compared to a standard domestic contract. I take advantage of my unique dataset to further compare the wage penalty linked to foreign versus domestic alternative work arrangements. For this purpose, I augment Equation (1.10) with an additional indicator variable equal to one if the employee works at the receiving firm through a (domestic) temporary agency contract.[60] Estimates displayed in the last column of Table 1.5 show that both domestic and foreign outsourced workers face a significant wage penalty compared to incumbent domestic workers, but the wage penalty is *twice* larger for posted workers.[61] That suggests that foreign services suppliers are located even further at the bottom of the wage ladder compared to domestic contractors. To take into account permanent characteristics of workers, I follow Drenik, Jäger, Plotkin, and Schoefer (2020) and estimate a modified AKM model with separate workplace effects by work arrangements for the sample of receiving firms based on

$$\ln w_{it} = \alpha_i + \psi^{P_i}_{J_i,t} + \beta X_{it} + \epsilon_{it}, \tag{1.11}$$

where $\psi^{P_i}_{J_i,t}$ are work arrangement-specific firm fixed effects with P_i equal P if worker i has a posting contract and equals R if worker i is a incumbent domestic worker, and $J_{i,t}$ is the workplace. I control for

between 2017 and 2020. I then run the AKM specification on the connected set of employees who worked at some point for a receiving firm or non-receiving firm included in the random sample.

[60] The DADS dataset allows me to link employees hired at temporary employment agencies to the firm where the work mission is effectively performed since 2018. I use this information to observe, for a given firm purchasing posting services: (i) wages of incumbent domestic employees, (ii) wages of domestic outsourced workers (whose permanent employer is the temporary employment agency), and (iii) wages of posted workers (whose permanent employers are the foreign services suppliers).

[61] Interestingly, the wage penalty estimated for domestic outsourced workers in my French dataset is very close to what has been estimated by the literature relying on similar specifications: Drenik, Jäger, Plotkin, and Schoefer (2020) estimate a wage penalty of -0.140 for outsourced workers in Argentina.

age and age squared as well as the number of hours worked. The fixed effects are identified by worker wages changes when moving between different workplaces but are now allowed to differ across work arrangements.[62] I plot the distribution of workplace effects for posted and domestic workers in Panel B of Figure 1.10 in the sample of receiving firms. Workplace effects for posted workers are shifted downward compared to domestic workers. The mean wage premium for posted workers is -0.43 relative to the mean of workplace effects of workers normalized to zero.[63] Receiving firms thus pay lower wage premia (accounting for workers permanent characteristics) to posted workers.

The lower wage premia for posted workers compared to domestic workers is likely to reflect the degree of rent-sharing and pay differentiation for posted versus domestic workers. To finally shed light on rent-sharing between receiving firms and posted workers, I compare successively raw wages and wage premia for domestic and posted workers *at the same workplace*. The correlation between the two should mirror the amount of rent-sharing between receiving firms and posted workers: the lower that parameter, the less posted workers' pay premia are related to domestic pay policies. I start by plotting in Panel A of Figure 1.11 the binned scatter plot of the log average wage of posted versus incumbent domestic workers at the same workplace (red dots), absorbing five-digit sector fixed effects.[64] The figure shows a moderate and positive relationship between posted workers and incumbent domestic workers (log) wages at the same workplace, with an estimated slope of 0.21 (0.01). It means that firms that pay their domestic workers at higher wages also pay posted workers slightly higher wages, but the elasticity is small. To verify whether that effect is driven by tenure differences between posted and incumbent workers, I repeat the analysis looking at the relationship between incumbent domestic workers and newly hired domestic workers at the receiving firm (blue dots). I find that there is a much stronger relationship between newly hired workers and incumbent workers when they are hired through regular rather than posting arrangements (0.65 versus 0.21 slope).[65] I confirm this finding by estimating the elasticity of estimated premia received by posted workers (ψ_J^P) and domestic workers (ψ_J^R), following Card, Cardoso, and Kline (2016) and Drenik et al. (2020):

$$\psi_J^P = \alpha + \rho \psi_J^R + u_J. \tag{1.12}$$

Panel B of Figure 1.11 shows the binned relationship between domestic and posted workers workplace effects.[66] The estimate of ρ is 0.11 (0.01), meaning that the pass-through of the firm-level wage premium to posted workers is essentially nil. Posted workers do not share firm's rent compared to domestic work-

[62] As there are no worker movement in and out of posting work arrangements, the fixed effects are therefore not identified through changes across the type of contracts for the same worker, but rather changes of workplace within the same type of work arrangement (posting or domestic employment). I estimate Equation (1.11) on the set of firms that are observed at least once as purchasing posting services between 2017 and 2019. Recall that posted workers cannot move across workplaces that are not using posting services, as posted workers are never observed as domestic workers.

[63] As what has been estimated for domestic outsourcing by Drenik, Jäger, Plotkin, and Schoefer (2020), the dispersion of wage premia is similar across work arrangements: I estimate a raw standard deviation of 0.37 for the posted worker wage premium and 0.32 for the domestic worker wage premium.

[64] In the Appendix, I present the same correlational plot without adjusting for sectors effects.

[65] I further show in Appendix that the slope between the incumbent and domestic outsourced worker wage is higher than the one between incumbent and posted workers (0.27 versus 0.21).

[66] As noted by Card et al. (2016)and Drenik et al. (2020), a normalization of workplace effects is necessary to interpret the elasticity as the amount of workplace premia earned by domestic workers that posted workers receive at higher paying firms. I thus follow Drenik et al. (2020) and normalize workplace effects to zero in the lowest decile for each type of work contract. The normalization does not affect the estimate of ρ.

ers employed at the same workplace, suggesting receiving firms can cut labor costs by relying on on-site offshoring.[67]

1.5 Mobile Services Export Surplus in Sending Countries

The past section provided evidence that cross-border provision of services is associated with displacement of domestic workers in receiving labor markets. What are the counterparts of that redistribution of market shares in services for sending countries? In this section, I document the export-mobility gains created by the posting policy in sending (mostly low wage) countries. I first estimate the gains from the posting policy at the industry-level. I then focus on sending-firms scale-up once they access foreign markets through cross-border provision of services.

1.5.1 Industry-Level Expansion After the Posting Policy Liberalization

To shed light on economic gains created by the posting policy for sending countries, I focus on the service trade liberalization in Poland, that provides the most striking example of the European "*posting success story*". Poland became the first supplier of posting services in Europe in 2004. Postings from Poland increased rapidly right after the end of posting restrictions in 2004, to reach an average level of 250,000 postings per year, leading the country to account for 20% of overall posting outflows while accounting for 7% of the overall European active population (Figure A.22, Panel A).

To study the effects of the 2004 export opportunity shock, I compare employment in non-tradable sectors affected and unaffected by the liberalization, before and after the 2004 accession, in Poland versus a comparable neighboring country that did not benefit from the liberalization. I use health and public sectors as controls as these are covered by licensing regulations that limit posting services provision in these sectors. To avoid picking up effects driven by simultaneous standard trade openness, I focus on construction as the only "pure" non-tradable sector treated by the liberalization reform.[68] Panel B of Figure A.22 shows that 50% of postings from Poland occur in the construction sector, while postings in health or public administration are almost 0%.

I use Ukraine as an additional control group. Ukraine shares a border with Poland and is of similar size, but it was not included in the first and second European enlargements: unlike Poland, the country did not gain the right to supply mobile services in 2004. Geographical and economic factors that could affect sectoral employment besides EU accession should therefore be similar in the two countries.[69] Ultimately,

[67] Pay-premium sharing between receiving firms and posted workers appears to be very moderate, particularly in comparison with what has been found for domestic outsourced workers. For comparison, Drenik, Jäger, Plotkin, and Schoefer (2020) compare workplace effects of temporary agency workers and regular workers in Argentina and find a slope of 0.49(0.007) indicating rent-sharing between receiving firms and workers in alternative work arrangements is five times lower for posting than domestic outsourcing. Many qualitative studies have shown that posted workers tend to have very low bargaining power: they are not covered by most receiving firms' work agreements, do not benefit from union representation in the receiving country, have low level of information about domestic workers due to language barriers, and have few direct interactions with receiving firms and domestic workers.

[68] Trade tariffs were, however, abolished gradually between 1990 and 2004 in prevision of Poland accession in 2004. For instance, the trade of industrial goods with the EU-15 was almost completely liberalized in 1999 under the provisions of the Europe Agreements.

[69] Of course, differences in EU accession are partially determined by differences in countries' development and openness, which may in turn affect employment dynamics. However, the level of development in Ukraine was sufficient over the period to lead to an EU association agreement, which was later unexpectedly canceled due to the election of a pro-Russian leader.

using Ukraine as a placebo hinges on the assumption that determinants of EU accession are not correlated with the *differential* evolution of postable and non-postable sectors, which seems plausible.

Panel A of Figure A.30 shows the evolution of domestic employment in exposed and unexposed sectors, before and after suppliers in the treated sector gained the right to supply services abroad through posting. Before 2004, treated and control sectors experienced very similar employment trends. Domestic employment in the Polish construction sector started to boom right after the liberalization, with an increase of more than 600,000 workers between 2004 and 2007. Employment in the sector treated by the reform stayed permanently high relative to its pre-2004 level and relative to the evolution observed for control sectors in the same country. Panel B of Figure A.30 shows that in the placebo country, employment trends in exposed versus sheltered sectors did not diverge in 2004, suggesting the effect detected in Poland is caused by the liberalization shock rather than sectoral-specific trends common to Ukraine and Poland. The triple differences estimates suggest that non-tradable employment in the sending country increased by 17% in the exposed sector after on-site offshoring was liberalized.

1.5.2 Sending-Firm-Level Mobile Services Export Gains

Figure A.30 provides motivating evidence that the trade liberalization in services triggers substantial gains in sending countries' non-tradable sectors. To better characterize gains from trade in non-tradables, I leverage granular data on firms exporting posting services within the EU.

The main dataset for the analysis is an administrative tax dataset covering the universe of non-financial corporations established in Portugal merged with exhaustive information on provision of services abroad by Portuguese firms over the period 2006-2017. Portugal provides an ideal laboratory to study non-tradable service trade because it is a low-wage country, relatively well endowed in labor, and is the top exporter of posting services in main receiving countries such as France and Belgium. To identify posting flows, I use the methodology of central banks and identify five-digit sector codes where cross-border supply of services can only be provided through posting of workers abroad.[70]

I start from the universe of Portuguese firms in "non-tradable" sectors for which I can observe all services provided abroad reported by each firm to the tax administration for the period 2006-2017.[71] Of these firms, I use the exhaustive information on provision of services to an EU country to identify the 4,151 firms that started posting workers to another member state between 2010 and 2015.[72] The average (and median) posting firm is small, employing a mean of 16 (7) workers in 2009 and operating in the construction of residential buildings (39%), road transportation (19%), electrical installation (5.2%), temporary employment provision (2.5%), and plumbing installation (2.4%). The posting export represents an average (median) of

[70]The analysis is thus restricted to non-tradable sectors that can only export their services through posting of workers following the MSITS 2010 classification, listed in the Appendix. The dataset and methodology are further described in detail in the Appendix .

[71]I focus on those who have at least a median of three workers across all years of activities. I also drop a minor number of firms that performed services in a country outside the EU, as these services provisions are not covered by the European posting regulation but by the restricted posting policy for non-EU member states.

[72]I restrict the treatment definition to firms that start providing services abroad for the first time in 2010 such that I can observe treated firms at least four years before the event and two years after. It allows me to define correctly their first "export event time" and to verify that firms that export services in 2010 were effectively not posting workers from 2006 to 2010. I further follow Alfaro-Ureña et al. (2019) by focusing only on firms with a median of three employees over the period. The Appendix provides descriptive statistics on all posting firms as well as an estimation sample coverage.

40% (22%) of the posting firms' turnover in the first year when they start posting abroad.

A. Identification Strategy

To uncover the effects triggered by posting in sending firms, I use an event study framework that investigates the effects for suppliers to provide their non-tradable services abroad for the first time.[73] Between 2010 and 2015, 4,151 events occur in Portugal among the 27 sectors in which non-tradable services exports can be identified in my administrative tax dataset. The empirical specification is

$$y_{it} = \alpha_i + \lambda_{spt} + \sum_{k=\underline{T}}^{\overline{T}} D_{it}^k \theta_k + \varepsilon_{it}, \tag{1.13}$$

where y_{it} is an outcome variable (in log) for firm i in calendar year t and α_i is a firm fixed effect. λ_{sptz} are five-digit sector $\times$ district $\times$ calendar year fixed effects. The event time dummies D_{it}^k are defined as $D_{it}^k = \mathbb{1}.[t = d_i + k]\ \forall k \in (\underline{T},\overline{T})$, $D_{it}^{\underline{T}} = \mathbb{1}.[t \leq d_i + \underline{T}]$, and $D_{it}^{\overline{T}} = \mathbb{1}.[t \geq d_i + \overline{T}]$, where $\mathbb{1}$ is the indicator function and d_i is the first year when firm i starts posting workers abroad. I normalize $\theta_{-1} = 0$ and set $\underline{T} = -5$ and $\overline{T} = +5$. I cluster standard errors at the province$\times$ event time level to account for spatial correlation in error terms as in Alfaro-Ureña et al. (2019).

The sequence of coefficients θ_k describes the dynamic of firms' outcomes around the event of the first service performed abroad. By comparing exclusively firms that export their services at some point between 2010 and 2015, the event study design conveniently rules out any selection issue related to the "exporter premium."[74] Formally, estimated θ_k compare the outcomes of posting firms in event year k to the outcomes of future posting firms in the same narrowly defined sector and province in the year before their event. As in Equation (1.8), the binning of event time coefficients at the ends of the event window allows me to introduce both year and firm fixed effects (Borusyak and Jaravel (2017), Schmidheiny and Siegloch (2019)).

The main question addressed by my event study design is how services suppliers outcomes would evolve in the absence of the export opportunity opened by the posting policy. My identification strategy relies on the assumption that firms that will post workers in the future form a credible counterfactual for firms that start posting workers after accounting for time-invariant differences between firms and common sector-district-year shocks. Interpreting the sequence of estimated θ_k as the causal effects of the mobility-related export opportunity requires that firms do not select into posting based on firm-specific shocks that would be correlated with firms' outcomes *in the absence of the posting policy*. What matters for identification is not that the timing of posting is random but rather the observed changes in posting firms' outcomes after the event require that firms have the ability to use posting mobility to access foreign markets. The counterfactual I am interested in is not what would happen to exporters if they had not chosen to take up the posting opportunity but instead what would happen to exporters in a world where they are constrained

[73] In spirit the exercise is similar to studies that investigate the effects of exporting or joining a global value chains on firms' performances such as Alfaro-Ureña, Manelici, and Vasquez (2019).

[74] Table A.12 shows the exporter premium and reports differences between firms that export or do not export non-tradable services. Following what has been found in the literature, exporting firms tend to be systematically different from non-exporting firms. The exporter premium is, however, lower in non-tradable services than in standard manufacturing, suggesting lower entry costs into exporting in service trade.

to provide services solely in the domestic market (no posting mobility). The only threat to identification lies in firm-specific shocks that (i) affect the timing of posting of workers, (ii) affect firms' outcomes after the event of first services exports, (iii) do not affect firms' outcomes before the event, and (iv) would affect firms' outcomes after the event even in the absence of the service export opportunity.[75]

Ultimately, it is difficult to identify these unobserved factors without additional data on firm-specific shocks. The results from the event studies regressions will allow me to evaluate whether the timing of first posting is driven by the past differential evolution of outcomes between the treated and the control group. Focusing on non-tradable sectors further restricts potential unobserved shocks caused by automation or innovation events that could affect firms' performances in domestic markets even in the absence of exporting opportunities. To gauge whether firm-level shocks simultaneous to the posting event affect firms' activity at home, in Section 5.2.2 I investigate what happens to a firm's domestic sales when it starts providing services abroad. I then exploit differences in posting missions across treated firms to show that the posting export event is the prime driver of the estimated θ_k. Finally, in Section 5.1.4 I compare posting firms' outcomes to those of similar firms operating in sectors shielded from posting opportunities.

B. Baseline Results on Sending-Firms Scale

In a world where companies are allowed to provide services abroad through posted workers, how much do they gain in doing so? Figure 1.12 plots the event study coefficients estimates for firms' total employment, turnover, assets, total hours worked, cash deposit, and wage bill, with corresponding estimates displayed in Table 1.6. The results show that providing non-tradable services abroad is associated with a large and permanent expansion of services supplier activity. The second year after the first posting export, total employment in sending firms increases by 30%, turnover and hours of work increase by 56%, and total wage bill increases by 72%, compared to firms that have not yet posted workers that year. The increase in sending firms' sales triggered by the mobile services export opportunity is not purely driven by a price effect, as services suppliers significantly scale up their use of labor inputs. In addition to increasing total hours of work, sending firms also grow at the extensive margin and hire significantly more employees. I find no evidence of selection into posting based on past firm growth in terms of economic activity, suggesting the timing of the first posting is not correlated with past differential evolution in outcomes across firms. It is only after sending firms start providing non-tradable services abroad that they experience strong growth.

To prove that posting is driving such gains, rather than unobserved firm-level shocks, I exploit heterogeneities in duration of posting missions across firms. I run Equation (1.13) separately for each of treatment duration groups in order to show heterogeneities in export gains depending on posting take-up duration.[76]

[75] If a services supplier experiences a productivity shock in a given year, and if this productivity shock leads the firms to post workers this given year and this productivity shock would boost firms' activity even without the possibility of providing services abroad, then the interpretation of θ_k as the effects of the posting opportunity are biased. If a services supplier starts posting workers abroad because of an information shock or a demand shock from a foreign customer, the identifying assumption is not violated. Similarly, if a services supplier innovates in a given year, and if this innovation allows this firm to provide services abroad but would not affect firms' sales at home in the absence of the posting opportunity, the estimated coefficients can still be interpreted as the gains created by the posting opportunity for firms.

[76] I divide my baseline group of treated firms into five groups: firms that are only posting during one year, firms posting for two consecutive years, firms posting for three consecutive years, firms posting for four consecutive years, and firms that keep posting workers for the entire period of observation after their first posting. The distribution of first posting events and their duration over

Figure 1.13 shows that firm-level scale-up effects are simultaneous to the posting mission but do not last after the firm stops providing services abroad. For firms that post workers for three years consecutively, wage rates, profits, and employment start to significantly increase the year of the event relative to the pre-posting event but return to their pre-posting level in fourth year, e.g., when the posting mission ends. By contrast, the treatment effects are larger and last for firms that keep posting workers abroad permanently after their first non-tradable export. Figure 1.13 shows clear evidence that the posting opportunity is driving the large changes in firm-level outcomes, rather than other shocks.

C. Distribution of Posting Gains: Capitalists, Workers and Government

How is the increase in firms' activity triggered by the mobile services export opportunity shared between workers, firms and government in sending countries? I plot in Figure A.26 social security contributions and income taxes paid by sending firms around the event of the first services export. As sending firms' expand their wage bill after posting, social security contributions paid by sending companies start to increase right after they start supplying non-tradable services abroad. Sending firms also increase their corporate income tax payments once they start providing services abroad. Those results emphasize the radically different fiscal implications of trade-related mobility compared to standard migration: while emigration leads to tax losses, posted workers generate additional (substantial) tax revenues for sending governments.

I then investigate the effects of non-tradables exports on sending firms' profit and wages. Panel A of Figure 1.14 plots the event study coefficients with 95% confidence intervals for firms' hourly wage rates estimated from Equation (1.13) on the restricted sample of treated firms, with corresponding estimates displayed in Table 1.7. Wages of workers in firms that have yet to post workers evolve similarly before the event. The wage rate in sending firms starts to increase the year of the first posting provision compared to firms that do not yet export non-tradables this year and are in the same five-digit sector and province. Wage rate increases by 14% in treated firms two years after they start providing services abroad relative to the pre-posting year and relative to wages in firms that do not post workers yet. The increase in posting firms' hourly wages is persistent, stable, and statistically significant at the 1% level for the five-plus years after the event. Panel B of Figure 1.14 shows similar estimates for sending firms' profits. Firms that post workers and firms that are yet to post workers thus face similar profits evolution before the event, while earnings of sending firms compared to control firms increase by 9% the year of the first posting. Profits then increase by 37% in treated firms two years after they start providing services abroad relative to the pre-posting year and to profits in firms that do not post workers yet. Those results outline that capital owners derive profit gains from non-tradable services exports that are twice larger than wage gains redistributed to employees. It is even clearer focusing on the sample of permanent exporters of posting services, limiting noise in the measure of sending firms' profits. Figure A.27 shows the large differences in wages and profits gains split at sending firms.

time is described in the Appendix.

D. The Role of the Posting Policy in Explaining Posted Workers' Wage Gains Are posted workers' wage gains explained by the service trade policy? Posted workers cannot be paid under the destination-level minimum legal wage, forcing sending firms to pay an additional posting allowance to their workers in some cases. I provide suggestive evidence of this mechanism in two successive steps.

While the firm-level data do not contain information on destination countries linked to each posting mission, I observe the decomposition of aggregate exports of posting services from Portugal in the EU-wide dataset on bilateral posting flows. Figure A.39, panel A, shows that most of posting services supplied by Portuguese firms are performed in high-wage countries. The average destination minimum legal wage faced by Portuguese firms is much higher than the level of wages paid by these firms before the posting mission (Figure A.39, panel B). It suggests that sending firms may indeed be constrained to pay higher wages due to posting policy. To verify this assumption, I re-estimate my baseline specification separately on the sample of sending firms with pre-posting wages below or above the average destination-level minimum wage index. Figure A.40 confirms that only firms with wages below the destination-level minimum legal wage increase their workers' wages during the posting mission. That provides suggestive evidence that wage gains are driven by the trade policy, rather than surplus-sharing.

The ideal test for that assumption requires to access similar data in a country that is not constrained by destination-level minimum wage policies. I use an additional administrative dataset on postings with heterogeneities in prevailing wage bindingness across sending countries. Luxembourg has the highest minimum legal wage in the EU,[77] and therefore posting firms in Luxembourg are not constrained by the prevailing wage policy, while Portuguese firms are.[78] I use administrative exhaustive data on posting firms in Luxembourg to repeat my baseline analysis.[79] If wage gains are explained by the destination-specific minimum wage rules, workers posted from Luxembourg should not benefit from wage gains when posted abroad. To ensure posting wage gains in Portugal and Luxembourg are comparable, I first show that posting firms located in Luxembourg exhibit a remarkably similar scale-up in terms of labor inputs (employment, hours of work) when they start exporting non-tradable services abroad compared to similar firms in Portugal. More specifically, I re-estimate Equation (1.13) for sending firms located in Luxembourg to compare those estimates with the baseline results for Portugal displayed in Figure 1.14. Results are displayed in Figure A.28. Remarkably, I find a strikingly similar growth in firms' employment and hours of work after that they start posting workers abroad, despite the estimates being performed in two different datasets and two different countries. I then investigate how this similar scale-up in posting firms' activity translates into potentially different posted worker wage increases in Luxembourg and Portugal. Panel C compares the evolution of (log) wage in posting companies before and after they start providing services abroad, for firms located in Portugal (red line) or Luxembourg (black line). While Portuguese employees experience a substantial increase in wages after their employer starts to provide non-tradable services abroad, employees

[77] 1,921 euros per month in 2015 versus 589 euros in Portugal

[78] This is exemplified in the Appendix, which displays the distribution of wages paid to workers posted to France by location of services suppliers. No workers posted from Luxembourg are paid at the French-level minimum wage, while almost 40% of Portuguese posted workers' exhibit a bunching at the minimum wage, suggesting that for these workers, the prevailing receiving country's minimum wage is binding.

[79] The dataset is described in the Appendix and consists of linked employer-employee data merged with information on E101/A1 form issued by all firms in Luxembourg.

of services suppliers based in Luxembourg do not benefit from wages increases when the posting mission starts. A similar scale-up in posting firms' activity after they start providing services abroad thus translates into important wage gains in the sending country constrained to pay a minimum allowance to its workers and no wage gains in the sending country not constrained by the destination-level policy. That provides support for interpreting the 10%-15% posting gains in the worker wage rate in Portugal as the result of destination-specific regulation rather than bargaining over surplus sharing between firms and workers.

E. Alternative Specifications and Robustness

I run several alternative specifications to check the robustness of the baseline estimates. The estimates are robust to using an additional control group of (i) firms shielded from the opportunity to provide services abroad even through mobile workers (Figure A.34) and (ii) never-posting firms matched with posting firms on pre-event variables (Figure A.38). I follow the rule-of-thumb tests suggested by Borusyak and Jaravel (2017) and Schmidheiny and Siegloch (2019) by showing that the estimates are not drastically changed when omitting unit fixed effects or estimating the model in semi-dynamic rather than fully dynamic form (Figure A.35, Panel A).[80] Therefore, the estimates accounting for heterogeneous treatment effects and negative weighting using the estimator developed in De Chaisemartin and d'Haultfoeuille (2019) are similar (figure A.25, figure A.24). To prove my results are not driven by biases due to the composition of the estimation sample, I also show that the estimates are robust to balancing the panel around the event time (Figure A.37). Finally, I run a placebo analysis by estimating Equation (1.13) on event times randomly assigned to my baseline estimation sample of 4,151 treated firms. Reassuringly, the estimates displayed in Figure A.36 show that no significant treatment effect of the placebo export event times can be detected

F. Magnitude and Incidence of Posting Gains: Lessons for Posting Policies

Following these large estimated gains, what are the lessons for posting policies, and the current negociations regarding liberalization of these policies in new generation trade agreements. To put the results in the perspective of the policy debate, two questions remain to be answered: how large are these gains as compared to more standard trade policies, and who do they benefit to?

To gauge the size of the gains from non-tradable trade compared to more standard globalization channel, I benchmark the posting gains with comparable estimates for manufacturing trade, repeating the baseline event study of Equation (1.13) on the sample of manufacturing exporters.[81] Figure A.29 shows that manufacturing exporters experience a similar dynamic scale-up in their activity after they start exporting goods in foreign markets.[82] Figure 1.15, Panel A, summarizes the average gains from trade, measured by θ_k, from usually studied international integration channel (standard manufacturing exports, blue bars) and the novel integration channel (pink bars). Exporters of "non-tradable" services experience a similar growth (relative

[80] When the estimates are largely affected by the omission of unit fixed effects, this could also indicate that negative weighting across treatment groups can represent a significant bias.

[81] Table A.12 provides descriptive statistics on manufacturing exporters and compares them to posting firms.

[82] The estimated gains from non-tradable services' exports are also close in magnitude to those of Alfaro-Ureña et al. (2019) that focus on the effects for firms to start supplying to multinationals in Costa-Rica.

to their own pre-event size) in terms of sales and employment. The posting policy generates gains in sending countries of similar magnitude than standard exports, or standard FDI, the usual focus of industrial policies in low-wage countries. Given the size of the export-mobility opportunities opened by the posting policy, countries with competitive advantage in services have large incentives to lift barriers to cross-border provision of services.

The incidence of the gains, however, appears to be different. Figure 1.15, Panel B, describes the average differences between usual exporters, and firms that export manual services. Companies that benefit from the alternative trade instruments are significantly smaller, less capital intensive and less profitable than standard exporters. In addition of being smaller compared to usual exporters, firms that access foreign markets through posting are also younger and face lower barriers to exports, as compared to what is observed in manufacturing. Table A.12, column (1) and (2), show that the *exporter premium*, defined as the average difference between exporters and non-exporters outcomes within a given sector (Bernard et al. (2007)), is smaller in posting services than in manufacturing. Exporters are bigger than non-exporters in both sectors, but the selection into exporting based on firms' size and profitability is twice smaller in exports through posting policies. Consistent with this finding, Figure A.32, Panel A, shows that manufacturing exporters must pre-invest in machines before being able to reach foreign clients, while services suppliers can sell abroad without differential pre-investments compared to non-exporters. This is also consistent with the share of newly created firms among exporters being twice lower in manufacturing than in services supply (Table A.13).[83] The redistributive implications of liberalizing cross-border provision of services may thus be different compared to standard trade policies focused on manufacturing.

If firms benefitting from the novel integration channel are different than usual exporters, the long-term implications of these novel micro gains from trade seem to have different long-run implications. While firms (mechanically) increase their sales abroad when they start supplying services in another EU member state, they simultaneously *decrease* their domestic sales. In contrast, manufacturing exporters sell more at home after their first export. A possible rationale for this result is that services suppliers are constrained in their ability to serve both markets once they obtain a service contract abroad, while manufacturing firms can smoothly scale up their supplies once they increased their stock of assets. Services trade liberalization may thus generate different spillovers for domestic customers compared to standard trade openness.[84] Increases of tangible assets are also noticeably larger at manufacturing exporters.While sending firms exhibit a larger stock of assets after exporting non-tradable services, the effect is driven by cash holdings rather than tangible assets due to low capital intensity of services supply (Figure 1.12, Figure E). Figure 1.13 showed that firms do not grow permanently after the posting mission ends, suggesting that firms operating in non-tradable sectors exhibit little learning by exporting, which is consistent with manual services being characterized by weaker scope for productivity gains.[85] The (large) estimated export surplus opened by the posting policy

[83] This is consistent with Ariu (2016b) that finds that exporters of services (all services, not specifically non tradable services) tend to have higher entry rates than manfuacturing firms.

[84] A second rationale could be that manufacturing firms are more likely to start exporting once they experience an unobserved firm-level shock, such as innovation or automation, that simultaneously affects their ability to sell goods in foreign and domestic markets.

[85] I also test how TFP evolved in sending firms after they start posting workers abroad. I measure TFP assuming a standard Cobb-Douglas technology, using a simple OLS framework where sales are the dependent variable and where employment, net assets and material costs, are used as time-varying controls. To take into account potential endogeneity in input choices at the services supplier

thus appears to be driven by increased market shares abroad rather than structural changes at the sending company.

1.6 Consumer Gains From Liberalizing "Non-Tradable" Service Trade

The liberalization of cross-border provision of services generated employment losses for low-paid workers in exposed sectors and receiving countries, while allowing sending-firms in low wage countries to experience substantial growth. What is the magnitude of the efficiency gains from such reallocation of market shares in services? I close the paper by turning to the consumer gains created by the liberalization in Europe, building on a standard conceptual framework for the cross-border sourcing of services. I use a model with full competition, implying reallocation of workers in the long-run. Those assumptions allow me to get somehow an upper bound for the gains from increased international competition in services. Obtaining an upper bound is crucial for policy makers to gauge the potential gains that can arise from posting policies, even in the absence of long-run persistent effects on labor markets.

1.6.1 A Model of Cross-Border Provision of Services

I use a model of service trade drawing on standard Eaton and Kortum (2002). I consider a world with a finite number of countries $i \in S$ and a continuum of services Ω_n that every country can produce. In this world, services can be supplied by foreign countries through the geographical mobility of workers.

A. Demand of Services

A representative consumer in country j with CES preferences consumes services:

$$U_j = \left(\int_{\Omega_n} S_j(n) dn \right)^{\frac{\sigma}{\sigma-1}},$$

where Ω_n is the set of non-tradable services and $S_j(n)$ is the quantity of services n consumed by country j. The CES preference yields a Dixit-Stiglitz price index:

$$P_j = \left(\int_{\Omega_n} p_j(n)^{1-\sigma} dn \right)^{\frac{1}{1-\sigma}}. \tag{1.14}$$

B. Supply of Services

Services are produced by combining hours of labor with country i's efficiency in producing services n $z_i(n)$. Unit labor costs in sending countries are gross wages paid to workers (including payroll taxes and other allowances) divided by productivity ω_i/z_i. To supply services from one country i to another country j,

level, I also use methods proposed by Ackerberg, Caves, and Frazer (2015). The results in Figure A.31 show that sending firms exhibit limited TFP changes after they start posting workers abroad. These TFP changes could be further driven by changes in margins or prices when providing services abroad.

there are mobility costs and frictions m_{ij} that resemble the standard iceberg trade cost. The unit labor cost for services performed by workers posted from i to j is

$$C_{ij}(n) = \frac{\omega_i}{z_i(n)} m_{ij} = \frac{c_{ij}}{z_i(n)}. \tag{1.15}$$

There is perfect competition across service suppliers. Each service is purchased from the country that offers the service at the lowest unit labor cost, including posting bilateral cost. Using the assumption of Fréchet distributed productivity such as $F_i(a) = exp\left\{-(T_i z)^{-\theta}\right\}$, I can derive for each service n the probability that i provides the lowest price service in country j. The share of services in country j performed by workers posted from country i is given by

$$\lambda_{ij} = \frac{T_i\left(c_{ij}\right)^{-\theta}}{\sum_{k\in S} T_i\left(c_{kj}\right)^{-\theta}} \tag{1.16}$$

C. Equilibrium, Welfare and Counterfactual Analysis

I use market clearing conditions to close the model. I denote X_{ij} the expenditure of country j on services produced by workers posted from country i and $X_j = \sum_i X_{ij}$ is country j's total spending in services, and $X_{ij} = \lambda_{ij} X_j$.[86] From Equation (1.16) we can write $X_{ij} = T_i(c_{ij})^{-\theta}\Phi_j^{-1}X_j$ with $\Phi_j = \sum_{k\in S} T_i\left(c_{kj}\right)^{-\theta}$. In equilibrium, total income in country i must be equal to total spending on services from country i such that

$$Y_i = \sum_j \frac{T_i \omega_i^{-\theta}(m_{ij})^{-\theta}}{\sum_k T_k \omega_i^{-\theta}(m_{kj})^{-\theta}} Y_j. \tag{1.17}$$

From the CES preferences of the final consumer, the welfare of individuals is given by a combination of their income and the price index they face. One question when thinking about consumer welfare in this paper's context is whether the price index is one of receiving or sending countries. Most of the time, the posting of workers describes a temporary work mission abroad where most of the workers' consumption is paid off by employers.[87] I thus use the simplifying assumption that a representative consumer of country i earns consumes in his sending country. Welfare of the representative consumer in country i is:

$$W_i = \frac{\omega_i}{P_i}. \tag{1.18}$$

From Equation (1.16) and the price equilibrium, we have $\lambda_{ij} = T_i C^{-\theta}\omega_i^{-\theta}(m_{ij})^{-\theta}P_j^{\theta}$.[88] As in Arkolakis, Costinot, and Rodríguez-Clare (2012), using the fact that $m_{ii} = 1$, welfare can be expressed as a function of domestic non-tradable services share λ_{ii} and the structural posting elasticity parameter:

$$W_i = \lambda_{ii}^{-\frac{1}{\theta}} C^{-1} T_i^{\frac{1}{\theta}}, \quad \hat{W}_i = \hat{\lambda_{ii}}^{-\frac{1}{\theta}} \tag{1.19}$$

[86] It follows from the Fréchet assumption that the fraction of services purchased from a particular sending country λ_{ij} is equal to the fraction of country j's income spent on services produced by country i, which I denote Π_{ij}. Closing the model with equilibrium conditions follows standard derivations.

[87] For instance, micro administrative data from France show that for 80% of posting missions, workers' housing, food, and trip were paid by firms and not by the workers themselves.

[88] With $C = \Gamma(\frac{\theta+1-\sigma}{\theta})$ and $\Gamma(t) = \int_0^\infty x^{t-1}e^{-x}dx$ the Gamma function.

A change in the representative consumer welfare of country i after a given posting policy shock can be inferred from changes in equilibrium changes in posting shares ($\hat{\lambda}_{ii}$) and the posting elasticity (θ). In the range class of trade models resembling Equation (1.16), one can rely on "exact hat algebra" (Dekle et al. (2008)) to express the counterfactual trade flows after a policy shock. Denoting the ratio of the variables in the new and old equilibrium following a change in posting frictions as $\hat{x} = x^{'}/x$, the consumption shares (in services) after the policy change are given by

$$\hat{\lambda}_{ij} = \frac{\hat{T}_i \left(\hat{\omega_i}(\hat{m_{ij}})\right)^{-\theta}}{\sum_k \lambda_{kj}\hat{T}_k \left(\hat{\omega_k}(\hat{m_{kj}})\right)^{-\theta}}. \tag{1.20}$$

On the other hand, using Equation (1.17) and Equation (1.21),

$$\hat{Y}_i Y_i = \sum_j \frac{\lambda_{ij}\hat{T}_i \left(\hat{\omega_i}(\hat{m_{ij}})\right)^{-\theta}}{\sum_k \lambda_{kj}\hat{T}_k \left(\hat{\omega_k}(\hat{m_{kj}})\right)^{-\theta}} \hat{Y}_j Y_j. \tag{1.21}$$

I obtain a system of equations from which I can get $\hat{Y}_i$ as a function of policy shocks and initial observables. To simulate the effects of a policy shock $\hat{m_{ij}}$accouting for general equilibrium changes, Equation (1.20) allows me to combine observed λ_{kj} with estimates of θ. Importantly, the model focuses on the service sector only. The overall welfare effects of posting policy shocks will capture real wages changes in the service sector and need to be scaled-down by the share of services in overall consumption.

1.6.2 Model-Based Welfare Calibration

I use the model's structure to assess the welfare effects of the service trade liberalization in Europe, accounting for general equilibrium changes in countries' income. I consider the liberalization of the posting policy for NMS as my main experiment. I combine my estimated reduced-form coefficient β (1.8) on a dummy for the reform estimated from Equation (1.1) with estimates of θ. It allows me to measure $\hat{m}_{ij}$ the structural change in service trade cost following the liberalization of the posting policy to NMS. To get estimates of the trade elasticity θ, I use estimated elasticities that are presented in Chapter 2 of this thesis.

Using the initial value of service production of each member state (Y_i) and the original posting shares (λ_{ij}), I can plug the estimated change in posting cost $\hat{m}_{ij}$ into Equation (1.21), which defines a system of equations determining $\hat{Y}_i$ for each member state. Using my structural estimates of θ, I can substitute the change in posting frictions $\hat{m}_{ij}$ and in income $\hat{Y}_i$ into Equation (1.20) to obtain the matrix of posting shares change $\hat{\lambda}_{ij}$. I iterate this procedure using a dampening factor until $\hat{\lambda}_{ij}$ stops changing, and can finally express the change in welfare induced by the liberalization by $\hat{\lambda}_{ij}^{-\frac{1}{\theta}}$.

Figure 1.16 shows the distribution of welfare gains derived from the lifting of mobility restrictions for NMS studied in Figure 1.4. The liberalization shock, or decrease in trade costs of services for NMS, acts as a positive productivity shock in the model, allowing all countries to source services from newly available suppliers. While the removing of posting barriers had large implications in terms of service trade flows, the overall welfare gains appear to be small. The liberalization of the posting policy to NMS countries has increased the average consumer gains in services by 0.3%. Small countries are more open and consume more services produced by foreign firms: they derive the largest relative gains from the liberalization. NMS gaining the right to supply services abroad see large welfare improvements, with top winners being Slovenia, Croatia, Slovakia, and Hungary. Portugal, Italy, and Spain derive smallest gains from the expansion of the posting policy to Eastern Europe, as they are the direct competitors of NMS for the cross-border provision of services. Large receiving countries, such as France and Belgium appear to derive moderate welfare gains from the increase in posting exposure, which are below 0.2%. Table 1.8, column 2, summarizes the changes in real consumption in services under the extreme case of *moving to autarky*. That policy shock considers closing all service trade, expressing the gains from the posting policy as $1 - \lambda_{ii}^{1/\theta}$. Under the restrictive scenario, welfare gains of the trade liberalization in services appear larger, increasing to up to 4% for small countries like Belgium or Luxembourg that consume a relative large share of their overall services through posting of workers. Overall, the changes in real consumption following the liberalization of trade in services remain modest, and tend to lie below what is usually quantified for overall trade.[89]

While the finding of small aggregate efficiency gains from "non-tradable" trade is close to what has been found for manufacturing, the underlying forces differ in some dimensions. The consumption shares of services performed by posted workers (λ_{ij}) are small, and much smaller than the consumption shares of imported goods. This standard "small number effect" is however counterbalanced by much lower substitutability of foreign and domestic services as compared to standard traded goods. With elasticities four times smaller than standard trade elasticities, much smaller expenditure shares in manual services in fact lead to non-trivial gains from international integration.

1.7 Concluding Remarks

Exploiting novel administrative data on a continent-wide experiment of trade liberalization in services, I use the European example to illustrate the redistributive implications of exposing novel jobs to international competition through posting policies. My results can be interpreted as a toolkit for policy makers discussing adopting these novel trade instruments, in the general context of declining share of manufacturing in advanced economies.

First, the definition of what jobs are tradable is a policy choice rather than a given parameter of the economy. Posting policies can expand the range of tradable activities and the magnitude of globalization. Those novel trade instruments open large market opportunities for low-wage countries, while high-wage countries are the net importers of those newly traded services.

Second, trade liberalization in services has long-lasting negative effects on labor markets in high-wage countries. Domestic employment in exposed sectors decreases following the liberalization, while receiving firms substantially lower their costs through posting. Workers do not significantly reallocate across labor markets or sectors, suggesting that adjustment of labor markets to trade shocks is also sluggish when focusing on trade in services.

[89] For instance, Costinot and Rodríguez-Clare (2014) find that in the same class of model, gains from trade are 7.5% for Belgium.

Third, posting policies have positive effects on labor markets and tax revenues of low-wage countries. Firms usually insulated from international trade experience substantial economic growth and profit gains once accessing foreign markets through posting, leading to higher tax revenues for origin governments. Wages increase, but not as much as profits, and are driven by destination-level minimum wage rules. Compared to import tariffs, the novel class of trade instruments benefit novel firms, that are smaller, younger and less capital intensive.

Fourth, trade liberalization in services had small efficiency gains for European consumers. The effect is driven by two countervailing forces. On the one hand, the share of services supplied by posted workers in total consumption remains low on average, because these services are heavily concentrated in some specific sectors, and because the posting policy only started to boom 15 years ago. On the other hand, posting services are much less substitutable than traded goods. Whether the latter will end up outweighing the former, as posting flows keep rising dramatically, remains an open question.

New generation trade instruments, by expanding the scope of globalization, open novel questions related to labor regulations in exporting countries. Because cross-border services are performed in their territory, receiving countries have the right to impose part of their fiscal and social standards to workers performing the exported services. Could we extend this logic to other trade flows, for instance, by imposing a set of core labor rights to all imports? Such an "anti-dumping" clause has, for instance, been recently proposed in a report commanded by President Macron on the future of economic challenges (Blanchard and Tirole (2021)). While I leave the answer to that question for future research, I have shown that posting represents a unique experiment where such policies have already been tested continent-wide.

Finally, the novel and numerous datasets leveraged in my analysis could allow us to overcome two major measurement challenges faced by the trade and labor literature. First, the paucity of empirical studies on trade in services, its determinants, and its consequences can be traced to the lack of reliable micro data on those transactions, as services are intangible and therefore absent from usual customs-based measures of trade flows. Identifying service trade through payroll tax information on posted workers helps reconstruct administrative records of service trade and could provide a trove of information for future research on the topic. Second, it is often impossible to track workers before and after they immigrate since no administrative data from any one country jointly observe individual labor market situations before and after a move. Following posted workers across borders could allow researchers to recover such usually truncated information around the mobility event and could thus provide novel answers on the dynamic path of earnings and employment for international migrants.

John M Abowd, Francis Kramarz, and David N Margolis. High wage workers and high wage firms. *Econometrica*, 67(2):251–333, 1999.

Ran Abramitzky, Leah Boustan, Elisa Jácome, and Santiago Pérez. Intergenerational mobility of immigrants in the united states over two centuries. *American Economic Review*, 111(2):580–608, 2021.

Daniel A Ackerberg, Kevin Caves, and Garth Frazer. Identification properties of recent production function estimators. *Econometrica*, 83(6):2411–2451, 2015.

Rodrigo Adao, Costas Arkolakis, and Federico Esposito. Spatial linkages, global shocks, and local labor markets: Theory and evidence. 2019b.

Rodrigo Adao, Michal Kolesár, and Eduardo Morales. Shift-share designs: Theory and inference. *The Quarterly Journal of Economics*, 134(4):1949–2010, 2019c.

Alonso Alfaro-Ureña, Isabela Manelici, and Jose P Vasquez. The effects of joining multinational supply chains: New evidence from firm-to-firm linkages. *Available at SSRN 3376129*, 2019.

Michael Amior and Alan Manning. Monopsony and the wage effects of migration. 2020.

Michael Amior and Jan Stuhler. Immigration and monopsony: Evidence across the distribution of firms. 2021.

Mary Amiti, Mi Dai, Robert C Feenstra, and John Romalis. How did china's wto entry benefit us consumers? 2017.

Joshua Angrist and Michal Kolesár. One instrument to rule them all: The bias and coverage of just-id iv. Technical report, National Bureau of Economic Research, 2021.

Pol Antràs and Robert W Staiger. Offshoring and the role of trade agreements. *American Economic Review*, 102(7):3140–83, 2012.

Pol Antras, Teresa C Fort, and Felix Tintelnot. The margins of global sourcing: Theory and evidence from us firms. *American Economic Review*, 107(9):2514–64, 2017.

Andrea Ariu. Services versus goods trade: a firm-level comparison. *Review of World Economics*, 152(1):19–41, 2016b.

Andrea Ariu, Florian Mayneris, and Mathieu Parenti. One way to the top: How services boost the demand for goods. *Journal of International Economics*, 123:103278, 2020.

Andrea Ariu, Katariina Nilsson Hakkala, J Bradford Jensen, and Saara Tamminen. Service imports, workforce composition, and firm performance: Evidence from finnish microdata. Technical report, National Bureau of Economic Research, 2021.

Costas Arkolakis, Arnaud Costinot, and Andrés Rodríguez-Clare. New trade models, same old gains? *American Economic Review*, 102(1):94–130, 2012.

David Atkin, Amit K Khandelwal, and Adam Osman. Exporting and firm performance: Evidence from a randomized experiment. *The Quarterly Journal of Economics*, 132(2):551–615, 2017.

David Autor, David Dorn, and Gordon H Hanson. The china syndrome: Local labor market effects of import competition in the united states. *American Economic Review*, 103(6):2121–68, 2013.

David H Autor, David Dorn, Gordon H Hanson, and Jae Song. Trade adjustment: Worker-level evidence. *The Quarterly Journal of Economics*, 129(4):1799–1860, 2014.

Sascha O Becker, Karolina Ekholm, and Marc-Andreas Muendler. Offshoring and the onshore composition of tasks and skills. *Journal of International Economics*, 90(1):91–106, 2013.

Andrew B Bernard and Teresa C Fort. Factoryless goods producing firms. *American Economic Review*, 105(5):518–23, 2015.

Andrew B Bernard, J Bradford Jensen, Stephen J Redding, and Peter K Schott. Firms in international trade. *Journal of Economic perspectives*, 21(3):105–130, 2007.

Andrew B Bernard, Teresa C Fort, Valerie Smeets, and Frederic Warzynski. Heterogeneous globalization: Offshoring and reorganization. Technical report, National Bureau of Economic Research, 2020.

Jagdish Bhagwati, Arvind Panagariya, and Thirukodikaval N Srinivasan. The muddles over outsourcing. *Journal of Economic perspectives*, 18(4):93–114, 2004.

Adrien Bilal and Hugo Lhuillier. Outsourcing, inequality and aggregate output. *University of Chicago, Becker Friedman Institute for Economics Working Paper*, (2021-05), 2020.

Olivier Blanchard and Jean Tirole. Major future economic challenges. *Report for President Macron*, (3):105–130, 2021.

Alan Blinder. Offshoring: The next industrial revolution. *Offshoring*, pages 1000–1017, 2006.

Alan S Blinder and Alan B Krueger. Alternative measures of offshorability: a survey approach. *Journal of Labor Economics*, 31(S1):S97–S128, 2013.

Kirill Borusyak and Xavier Jaravel. Revisiting event study designs. *Available at SSRN 2826228*, 2017.

Kirill Borusyak, Peter Hull, and Xavier Jaravel. Quasi-experimental shift-share research designs. Technical report, Review of Economic Studies, 2021.

Kirill Borusyak, Rafael Dix-Carneiro, and Brian K Kovak. Understanding migration responses to local shocks. 2022.

Kristin F Butcher and David Card. Immigration and wages: Evidence from the 1980's. *The American Economic Review*, 81(2):292–296, 1991.

Lorenzo Caliendo, Luca David Opromolla, Fernando Parro, and Alessandro Sforza. Goods and factor market integration: a quantitative assessment of the eu enlargement. Technical report, National Bureau of Economic Research, 2017.

Lorenzo Caliendo, Maximiliano Dvorkin, and Fernando Parro. Trade and labor market dynamics: General equilibrium analysis of the china trade shock. *Econometrica*, 87(3):741–835, 2019.

David Card. Immigrant inflows, native outflows, and the local labor market impacts of higher immigration. *Journal of Labor Economics*, 19(1):22–64, 2001.

David Card, Ana Rute Cardoso, and Patrick Kline. Bargaining, sorting, and the gender wage gap: Quantifying the impact of firms on the relative pay of women. *The Quarterly Journal of Economics*, 131(2):633–686, 2016.

Jiwon Choi, Ilyana Kuziemko, Ebonya L Washington, and Gavin Wright. Local economic and political effects of trade deals: Evidence from nafta. Technical report, National Bureau of Economic Research, 2021.

Michael A Clemens and Jennifer Hunt. The labor market effects of refugee waves: reconciling conflicting results. *ILR Review*, 72(4):818–857, 2019.

Sergio Correia. Linear models with high-dimensional fixed effects: An efficient and feasible estimator. *Unpublished manuscript, http://scorreia. com/research/hdfe. pdf (last accessed 25 October 2019)*, 2017.

Arnaud Costinot and Andrés Rodríguez-Clare. Trade theory with numbers: Quantifying the consequences of globalization. In *Handbook of international economics*, volume 4, pages 197–261. Elsevier, 2014.

Rosario Crino. Service offshoring and white-collar employment. *The Review of Economic Studies*, 77(2):595–632, 2010.

Clément de Chaisemartin and Xavier d'Haultfoeuille. Two-way fixed effects estimators with heterogeneous treatment effects. Technical report, National Bureau of Economic Research, 2019.

Jan De Loecker. Do exports generate higher productivity? evidence from slovenia. *Journal of international economics*, 73(1):69–98, 2007.

Frederic De Wispelaere and Jozef Pacolet. The size and impact of intra-eu posting on the belgian economy. with a special focus on the construction sector. 2017.

Frederic De Wispelaere and Jozef Pacolet. Posting of workers. report on a1 portable documents issued in 2017. 2019.

Robert Dekle, Jonathan Eaton, and Samuel Kortum. Global rebalancing with gravity: Measuring the burden of adjustment. *IMF Staff Papers*, 55(3):511–540, 2008.

Rafael Dix-Carneiro. Trade liberalization and labor market dynamics. *Econometrica*, 82(3):825–885, 2014.

Rafael Dix-Carneiro and Brian K Kovak. Margins of labor market adjustment to trade. *Journal of International Economics*, 117:125–142, 2019.

David Dorn and Josef Zweimuller. Migration and labor market integration in europe. *Journal of Economic Perspectives*, 35(2):49–76, 2021.

Andres Drenik, Simon Jäger, Miguel Pascuel Plotkin, and Benjamin Schoefer. Paying outsourced labor: Direct evidence from linked temp agency-worker-client data. Technical report, National Bureau of Economic Research, 2020.

Christian Dustmann, Uta Schönberg, and Jan Stuhler. Labor supply shocks, native wages, and the adjustment of local employment. *The Quarterly Journal of Economics*, 132(1):435–483, 2017.

Jonathan Eaton and Samuel Kortum. Technology, geography, and trade. *Econometrica*, 70(5): 1741–1779, 2002.

Peter S Eppinger. Service offshoring and firm employment. *Journal of International Economics*, 117:209–228, 2019.

Giovanni Facchini, Maggie Y Liu, Anna Maria Mayda, and Minghai Zhou. China's great migration: The impact of the reduction in trade policy uncertainty. *Journal of International Economics*, 120:126–144, 2019.

Teresa C Fort. Technology and production fragmentation: Domestic versus foreign sourcing. *The Review of Economic Studies*, 84(2):650–687, 2017.

Joseph Francois and Bernard Hoekman. Services trade and policy. *Journal of economic literature*, 48(3):642–92, 2010.

Simon Galle, Andrés Rodríguez-Clare, and Moises Yi. Slicing the pie: Quantifying the aggregate and distributional effects of trade. *Review of Economic Studies*, 2021.

Pinelopi Koujianou Goldberg and Nina Pavcnik. Trade, wages, and the political economy of trade protection: evidence from the colombian trade reforms. *Journal of international Economics*, 66(1):75–105, 2005.

Deborah Goldschmidt and Johannes F Schmieder. The rise of domestic outsourcing and the evolution of the german wage structure. *The Quarterly Journal of Economics*, 132(3):1165–1217, 2017.

Paul Goldsmith-Pinkham, Isaac Sorkin, and Henry Swift. Bartik instruments: What, when, why, and how. *American Economic Review*, 110(8):2586–2624, 2020.

Maarten Goos, Alan Manning, and Anna Salomons. Explaining job polarization: Routine-biased technological change and offshoring. *American economic review*, 104(8):2509–26, 2014.

Gene M Grossman and Esteban Rossi-Hansberg. The rise of offshoring: it's not wine for cloth anymore. *The new economic geography: effects and policy implications*, 2006, 2006.

Gene M Grossman and Esteban Rossi-Hansberg. Trading tasks: A simple theory of offshoring. *American Economic Review*, 98(5):1978–97, 2008.

Gene M Grossman, Phillip McCalman, and Robert W Staiger. The "new" economics of trade agreements: From trade liberalization to regulatory convergence? *Econometrica*, 89(1):215–249, 2021.

Keith Head and Thierry Mayer. Gravity equations: Workhorse, toolkit, and cookbook. In *Handbook of international economics*, volume 4, pages 131–195. Elsevier, 2014.

Keith Head and Thierry Mayer. The united states of europe: A gravity model evaluation of the four freedoms. *Journal of Economic Perspectives*, 35(2):23–48, 2021.

Elhanan Helpman and Paul R Krugman. *Market structure and foreign trade: Increasing returns, imperfect competition, and the international economy*. MIT press, 1985.

Chang-Tai Hsieh and Ralph Ossa. A global view of productivity growth in china. *Journal of international Economics*, 102:209–224, 2016.

David Hummels, Rasmus Jørgensen, Jakob Munch, and Chong Xiang. The wage effects of offshoring: Evidence from danish matched worker-firm data. *American Economic Review*, 104(6):1597–1629, 2014.

IACML. Analysis of bilateral and multilateral social security agreements as they relate to pensions, 2015.

David A Jaeger, Joakim Ruist, and Jan Stuhler. Shift-share instruments and the impact of immigration. Technical report, National Bureau of Economic Research, 2018.

J Bradford Jensen, Lori G Kletzer, Jared Bernstein, and Robert C Feenstra. Tradable services: Understanding the scope and impact of services offshoring [with comments and discussion]. In *Brookings trade forum*, pages 75–133. JSTOR, 2005.

Gueorgui Kambourov. Labour market regulations and the sectoral reallocation of workers: The case of trade reforms. *The Review of Economic Studies*, 76(4):1321–1358, 2009.

Lawrence F Katz and Alan B Krueger. The rise and nature of alternative work arrangements in the united states, 1995–2015. *ILR review*, 72(2):382–416, 2019.

Henrik Kleven, Camille Landais, Mathilde Munoz, and Stefanie Stantcheva. Taxation and migration: Evidence and policy implications. *Journal of Economic Perspectives*, 34(2):119–42, 2020.

Jongkwan Lee, Giovanni Peri, and Vasil Yasenov. The employment effects of mexican repatriations: Evidence from the 1930's. Technical report, National Bureau of Economic Research, 2017.

Ethan Lewis and Giovanni Peri. Immigration and the economy of cities and regions. In *Handbook of regional and urban economics*, volume 5, pages 625–685. Elsevier, 2015.

Runjuan Liu and Daniel Trefler. A sorted tale of globalization: White collar jobs and the rise of service offshoring. *Journal of International Economics*, 118:105–122, 2019.

Brian McCaig. Exporting out of poverty: Provincial poverty in vietnam and us market access. *Journal of International Economics*, 85(1):102–113, 2011.

Robert A Mundell. International trade and factor mobility. *the american economic review*, 47(3): 321–335, 1957.

Gianmarco IP Ottaviano and Giovanni Peri. Rethinking the effect of immigration on wages. *Journal of the European economic association*, 10(1):152–197, 2012.

Pascal Perrineau. *Le vote européen 2004-2005: De l'élargissement au référendum français*. Presses de Sciences Po, 2005.

David Ricardo. *Principles of political economy and taxation*. G. Bell and sons, 1891.

Gilles Saint-Paul. Making sense of bolkestein-bashing: Trade liberalization under segmented labor markets. *Journal of International Economics*, 73(1):152–174, 2007.

Kurt Schmidheiny and Sebastian Siegloch. On event study designs and distributed-lag models: Equivalence, generalization and practical implications. 2019.

JMC Santos Silva and Silvana Tenreyro. The log of gravity. *The Review of Economics and statistics*, 88(4):641–658, 2006.

Robert W Staiger and Alan O Sykes. The economic structure of international trade-in-services agreements. *Journal of Political Economy*, 129(4):1287–1317, 2021.

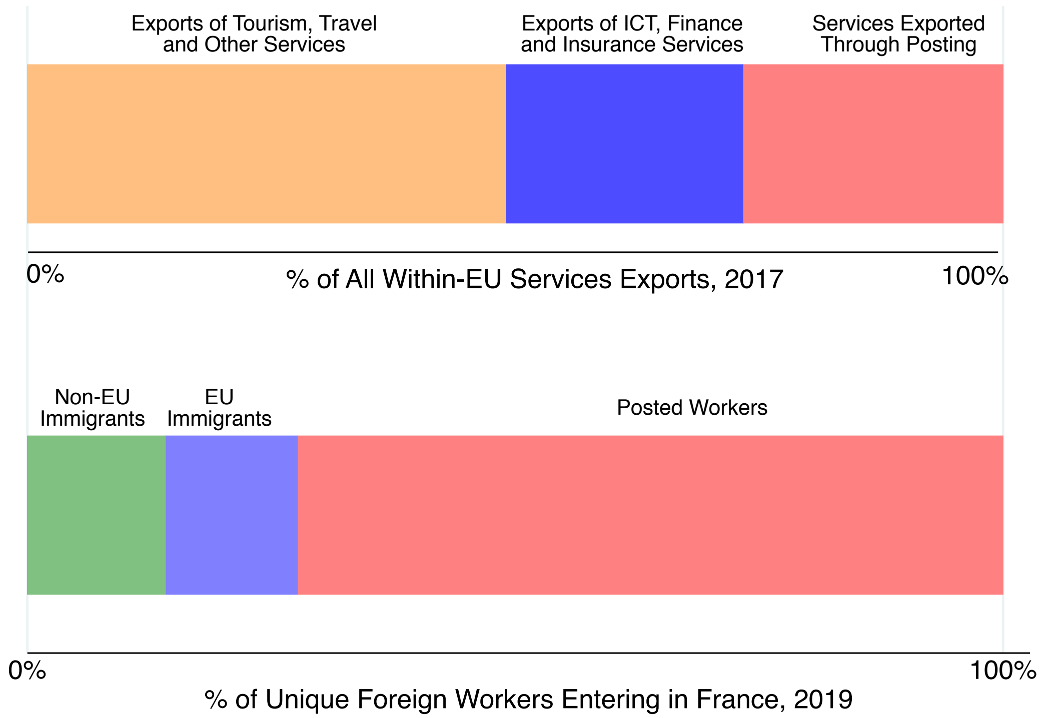
Marco Tabellini. Gifts of the immigrants, woes of the natives: Lessons from the age of mass migration. *The Review of Economic Studies*, 87(1):454–486, 2020.

Ellen G Yost. Nafta–temporary entry provisions–immigration dimensions. *Can.-USLJ*, 22:211, 1996.

Alwyn Young. Consistency without inference: Instrumental variables in practical application. 2019.

1.8 Figures And Tables

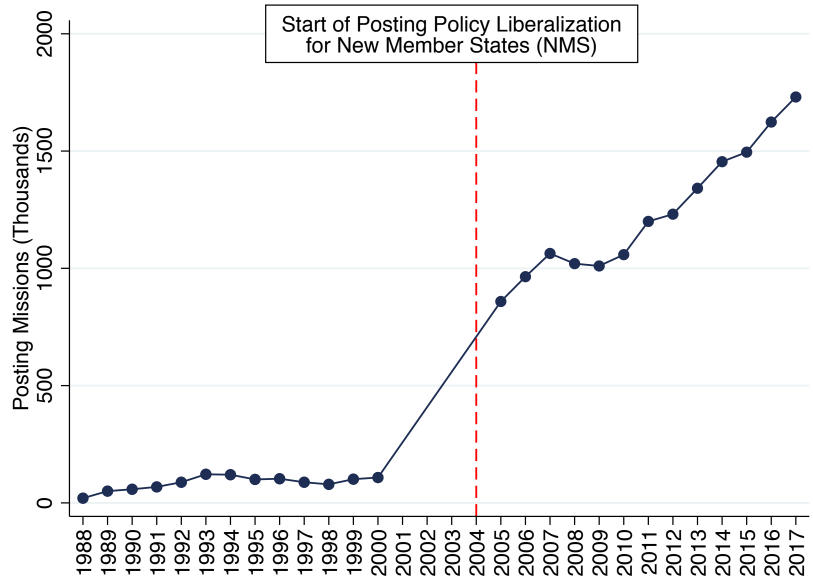
Figure 1.1: **Posting Flows and Globalization in the European Union**



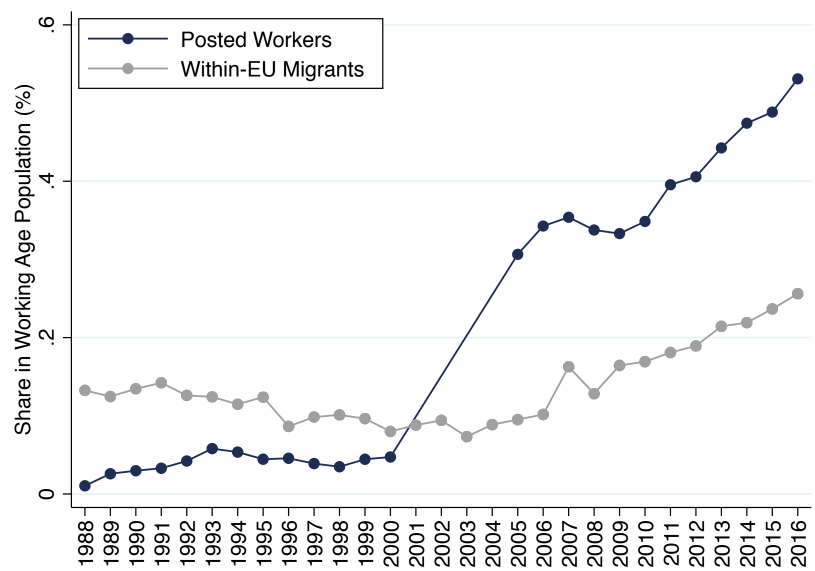
Notes: This figure benchmarks the size of trade-migration posting flows in EU to standard measure of trade in services and trade in factors. The top panel of the graph decomposes within-EU trade in service flows by type of transactions, using data on services' trade by mode of supply computed from Eurostat in 2017. Services exported through posting are services that are performed by workers posted abroad (mode 4 services supply of WTO). The bottom panel decomposes the incoming flows of foreign workers in France in 2019. Posted workers are sent temporarily by a foreign firm to perform a service in France, but do not have an employment contract in France and do not appear in standard French migration statistics. Data on workers posted to France come from administrative registries of all workers posted to France each year described in the Appendix. Data on standard immigrants entering in France come from the 2019 census (INSEE).

Figure 1.2: **Within-EU Services Offshoring Through Posted Workers**

A. Cross-Border Provision of Services Within-EU

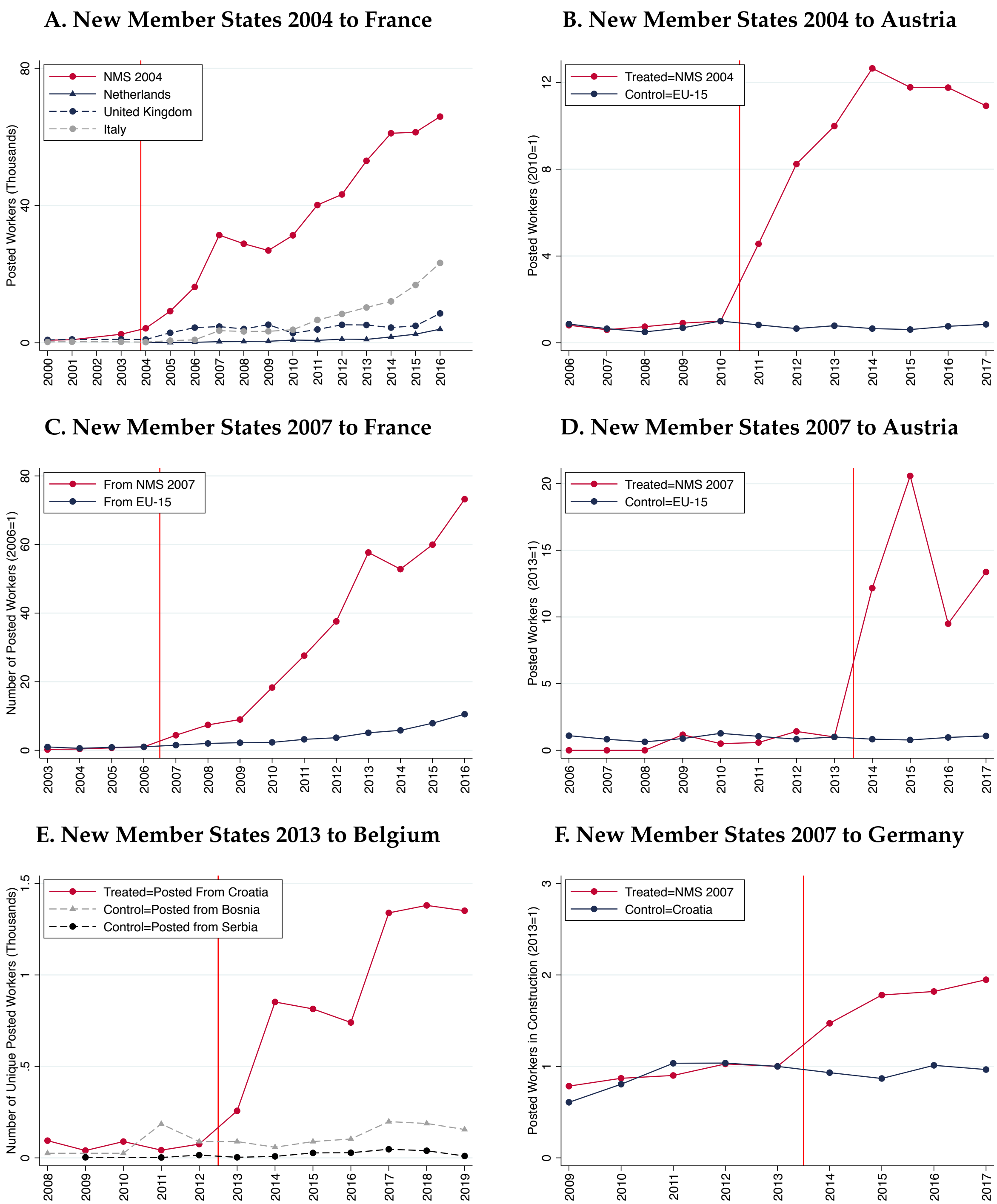


B. Trade-Related Mobility Is Larger Than Migration



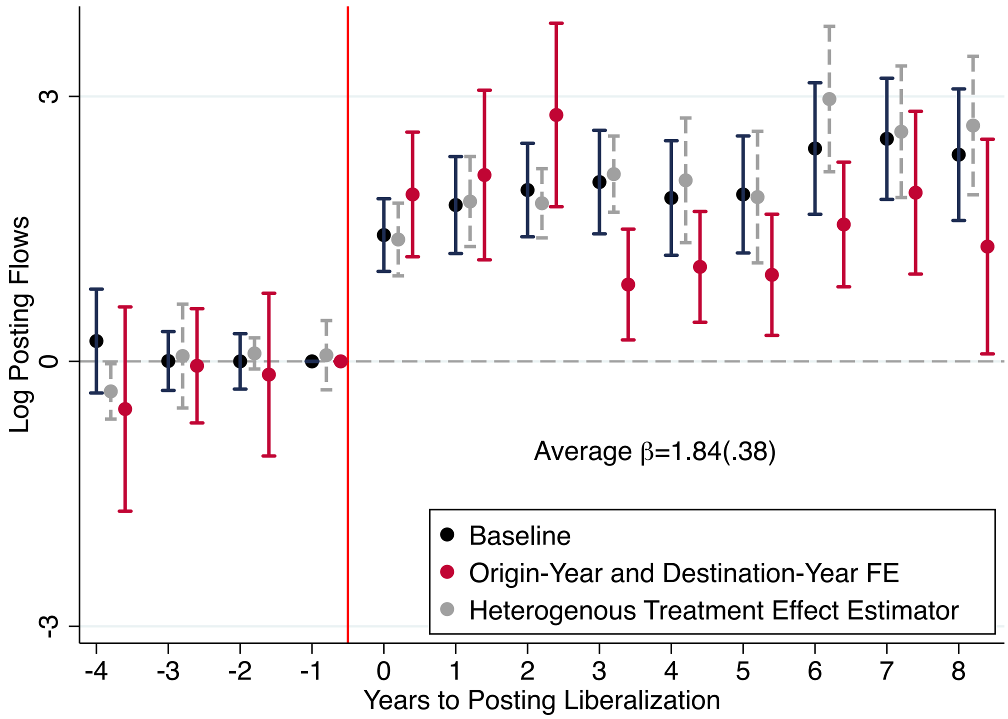
Notes: This figure describes the evolution of posting flows within the EU since 1988. From 2004 onwards, the posting policy was expanded to low-wage countries located in Eastern Europe (New Member States, henceforth NMS). Within the EU, posted workers must hold a E101/A1 mandatory certificate while performing a service mission in another member state. The yearly number of issued posting forms has been collected each year by the European Commission, with a break in data collection between 2000 and 2005. The top panel shows the yearly number of posting missions between EU member states based on the universe of E101/A1 social security posting forms issued each year in the EU. A worker may be posted several times during the year: posting forms relate to posting missions rather than unique workers. Panel B compares trade-related mobility flows (posting missions/population) to standard migration flows (migrants/population) within the EU. Migration flows are computed from the EU-LFS survey and measure the number of individuals who change, for at least 12 months, their residence country each year within the EU. Data on posting forms are described in detail in the Appendix.

Figure 1.3: **Lifting Entry Restrictions for Posted Workers: Raw Events**



Notes: This figure plots raw series of posting inflows around the end of mobility restrictions in receiving countries. The liberalization events are defined as a receiving country lifting all entry restrictions for workers posted from a given sending country. Panels A and C are based on exhaustive administrative declarations of posting missions performed by foreign suppliers to France for 2000-2016 recorded in the DPD/SIPSI dataset. Panels B and D are based on exhaustive administrative declarations of posting missions performed by foreign services suppliers to Austria between 2006 and 2017 recorded by the BUAK dataset. Panel E is based on exhaustive administrative declarations on postings to Belgium from 2008 to 2019 recorded in the LIMOSA dataset. Panel F is based on exhaustive administrative posting declarations on postings to Germany from 2000 to 2017 recorded by SOKA-BAU. Each figure compares postings from treated (red series) to control (dark series) sending countries to a given receiving country, before and after this receiving country lifted entry restrictions for treated countries (event depicted by vertical red line). The timing of these events is described in Figure A.2, Panel B.

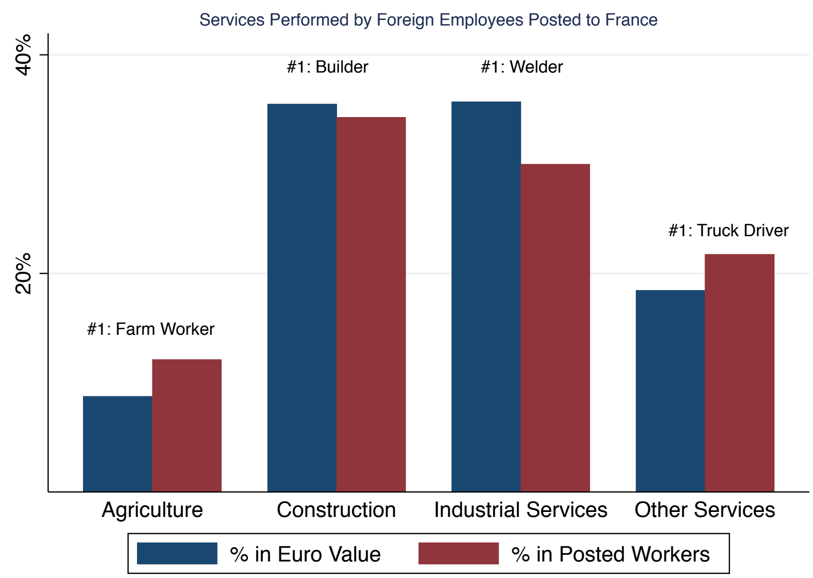
Figure 1.4: **Effect of Posting Liberalization on Cross-Border Supply of Services**



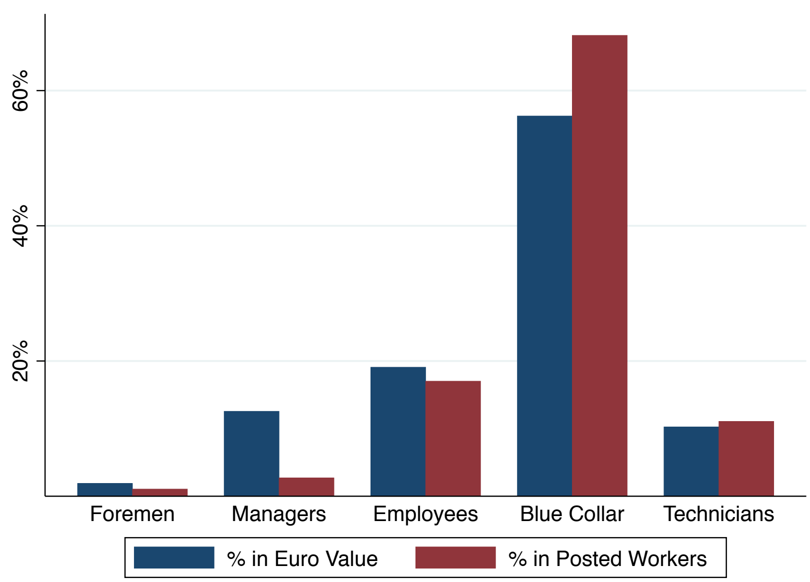
Notes: This figure reports the causal dynamic effects of posting liberalization in receiving countries on the volume of services performed by foreign suppliers' employees in that country. The event study is restricted to the four main receiving countries for which flows of posted workers can be observed before liberalization in country-level posting registries: Germany, France, Belgium, and Austria, and account for 60% of all received posting flows in Europe each year. The datasets pooled for the estimation are exhaustive administrative declarations of postings performed in (i) France (DPD/SIPSI dataset), (ii) Belgium (LIMOSA dataset), (iii) Austria (BUAK dataset), and (iv) Germany (SOKA-BAU dataset). The graph plots β_k coefficients and their 95% confidence interval from the dynamic staggered difference-in-differences Equation (1.1) that pools events and raw variations presented in Figure 1.3. The dependent variable is log posting flows from country i to j at time t. The treatment is defined as country i gaining the right to post workers without restrictions in country j at time t. The identifying variation is the liberalization from low- to high-wage countries within the EU, with staggered timing across origin-destination country pairs as described in Figure A.3. The coefficient of the year before liberalization β_{-1} is normalized to zero, and standard errors are clustered at the origin-destination level. A control country i is such that posting regulations from i to j never changes over the estimation period, e.g., is never or yet to be treated by the end of posting restrictions event. Hetererogenous treatment effects are computed using the De Chaisemartin and d'Haultfoeuille (2019) estimator correcting for negative weighting. Origin-year and destination-year fixed effects capture shifters of demand and supply of services. The reported coefficient is the average treatment effect of the posting liberalization over the post-reform period. Table 1.1 reports displayed estimates and standard erros, and shows similar estimation using a PPML estimator instead of the log transformation (Silva and Tenreyro (2006)).

Figure 1.5: **"Non-Tradable" Jobs Are Offshored On-Site Through Posting of Workers**

A. Sectors of Work Mission Performed by Posted Workers



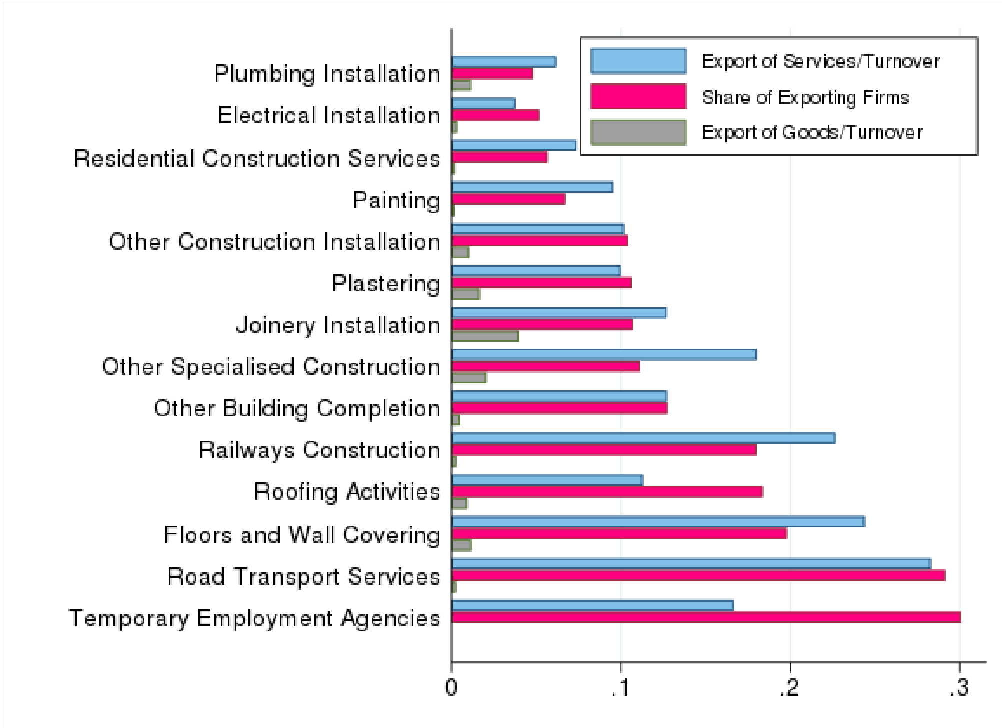
B. Qualification of Posted Workers



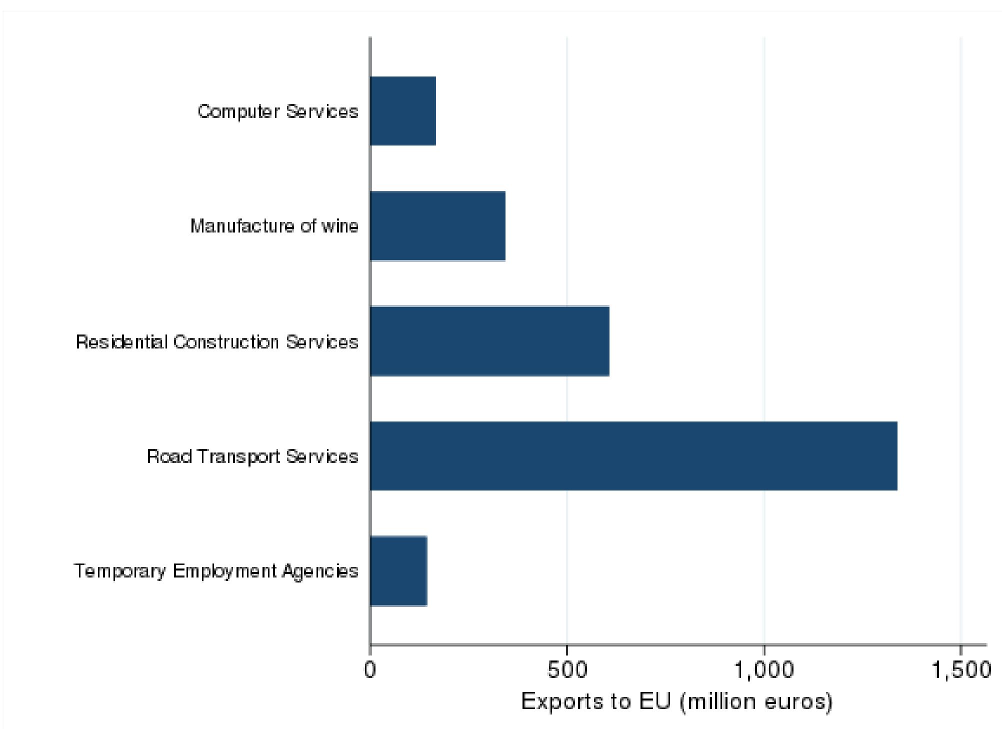
Notes: This figure shows the decomposition of posting missions performed by mobile (foreign) employees in 2019 in France, the second importing country of posting services in Europe. It is based on the DPD/SIPSI dataset that records all posting missions performed by foreign services suppliers in France's territory, with detailed information on posted workers' wage, posting mission duration, and type of job performed in France. In 2019, 657,216 posting missions performed by 227,991 unique posted workers were declared in the country. To compute the euro value of posting contracts, each posting mission is weighted by its duration and the wage paid to the foreign suppliers' employee. Panel A shows the decomposition of posting missions performed in France in 2019 by sector of that mission. The decomposition is computed with respect to the total number of posting missions (red bar) or total amount of posting missions (blue bar). Panel B shows the decomposition of posting missions by qualification level of the foreign employee performing that mission. Top jobs performed by posted workers are builder, welder, mechanic, cleaner, driver, and farm worker. The sector of the posting mission offshored "on-site" through posted workers is not necessarily the same as the sector of the receiving firm. The equivalent of Panel A for all European countries is available in Figure A.43. Data are described in Appendix. Top occupations of posted workers are listed in Table A.3.

Figure 1.6: **Exports in "Non-Tradable" Sectors Are in Fact Substantial in Sending Countries**

A. Exposure to Exports Opportunities in "Non-Tradable" Sectors



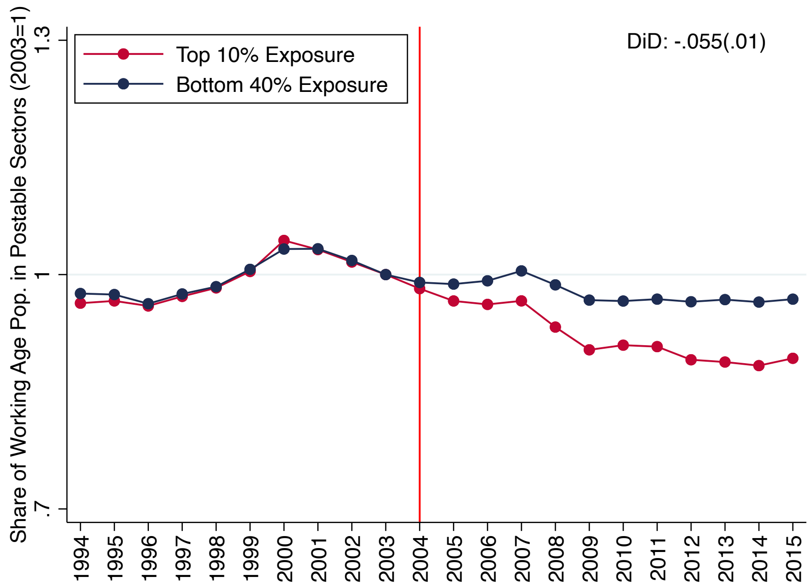
B. Portuguese Exports by Sectors



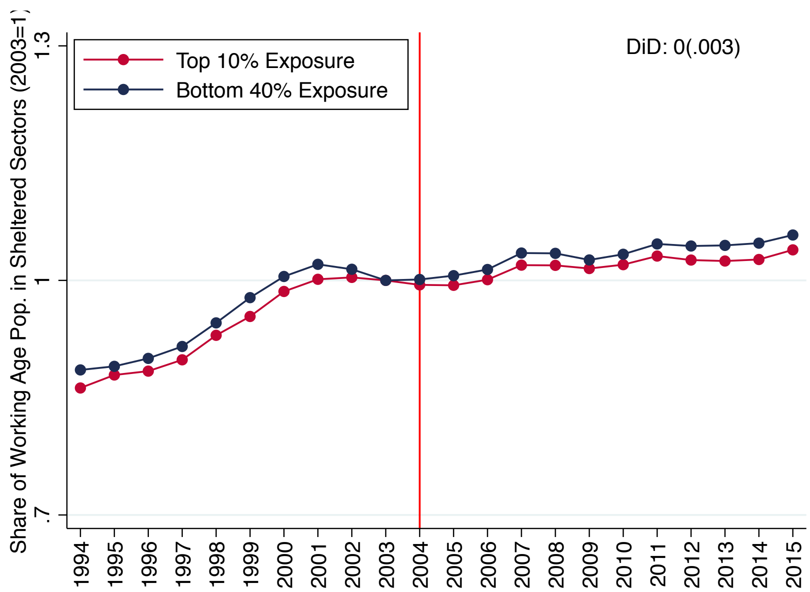
Notes: The Figure shows the amount of services and goods exports in non-tradable sectors in one of the main sending country: Portugal. I use exhaustive administrative tax records of Portuguese firms merged with administrative records of services performed in another EU country, as well as exported goods and materials, from 2006 to 2017, described in Appendix. The histogram shows for non-tradable sectors where trade in mobility-dependent, the total amount of services provided in EU (red) and total amount of goods exported to EU (blue) divided by total sales in that sector.

Figure 1.7: **Effect of the Posting Liberalization on Domestic Employment: Raw Series**

A. Domestic Employment in Exposed Sectors and Provinces



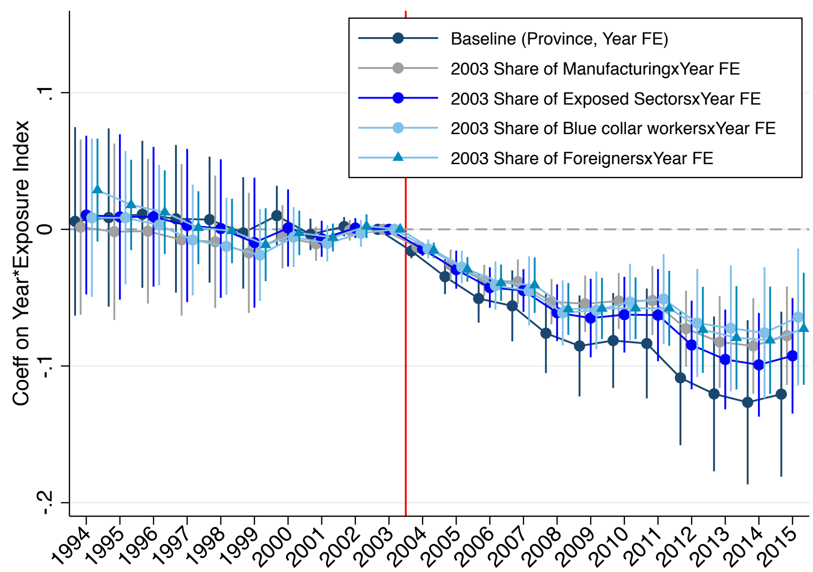
B. Domestic Employment in Sheltered Sectors



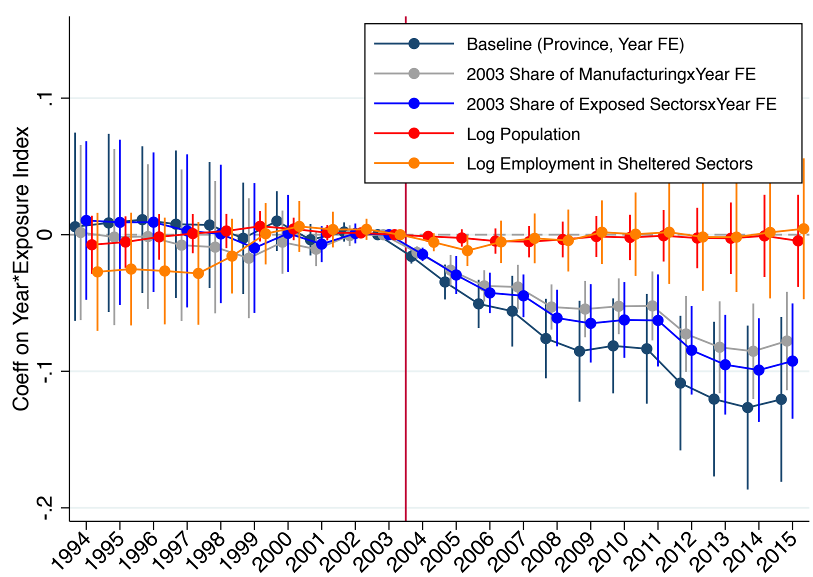
Notes: The figure studies the effect of a posting supply shock on domestic employment in the second largest importer of posting services: France. In mid-2004, France lifted entry restrictions for workers posted from 10 Eastern European countries, leading to permanent increased imports of posting services (see Panel A, Figure 1.3 and Table A.4). Province-level exposure to the supply shock is defined by a province imports of posting services per worker before the reform as described in the text and in Equation (1.2). The prediction power of pre-reform exposure (first stage) is showed in Table A.6, column (1). Exposed sectors are those for which posting inflows is non-zero (such as construction, agriculture, hotels and restaurants, temporary employment agencies, entertainment services and other manufacturing services, see top occupations in Table A.3). Panel A shows the evolution of the share of domestic workers in exposed sectors, before and after 2004, in provinces with low and high exposure to the shock. All series are normalized to one in 2003, the year before the reform. Panel B shows the counterparts for the share of domestic workers in sheltered sectors, such as retail or skilled and licensed services that exhibit zero posting imports. The coefficient reported in the graph is based on Equation (1.4) using log share of population employed in exposed sectors as the outcome variable. The corresponding estimate for the top figure using the share of population employed in exposed sectors in percentage points as the outcome variable is -1.25(.17). All coefficient are reported in Table 1.2.

Figure 1.8: **Effect of the Posting Liberalization on Local Labor Markets**

A. Log Exposed Employment by Exposure to Posting



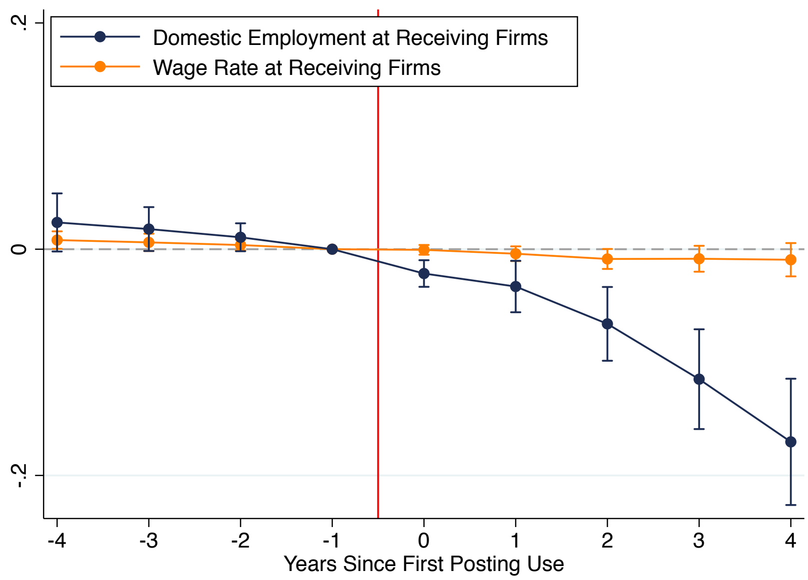
B. Sectoral and Migration Responses to the Shock



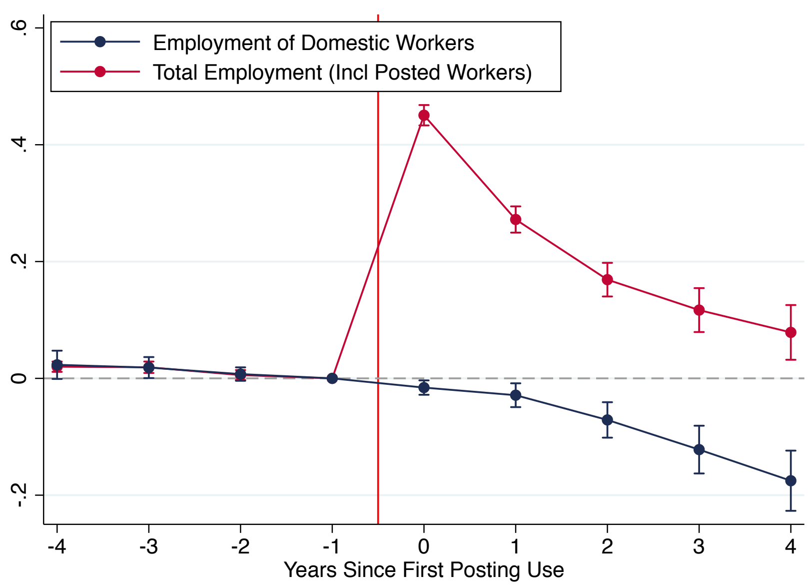
Notes: The figure displays the estimates from Equation (1.6) that capture the differential evolution of domestic employment in French provinces initially exposed to the liberalization of the posting policy. Panel A compares the evolution of domestic employment in provinces with more or less pre-reform exposure to posting. Initial exposure to the policy is measured by pre-reform imports of posting services per worker in a province. The dependent variable is the log employment in exposed sectors. The event is the lifiting of posting restrictions for services supplied by low-cost countries in 2004-2005. The coefficient of the year before the reform ζ_{2003} is normalized to zero. All regressions include calendar year and province fixed effects. The average difference in the exposure index between the least and more exposed province is 0.9. The vertical line represents 95% confidence intervals computed from robust standard errors clustered at the province level. Panel B repeats the estimation using as dependent variable the log of working age population in a province (red serie) and the log of employment in sectors not exposed to posting competition (orange serie).

Figure 1.9: **Employment and Wages At Receiving Firms After Using Posted Workers**

A. Domestic Employment Decreases and Wages Are Unchanged



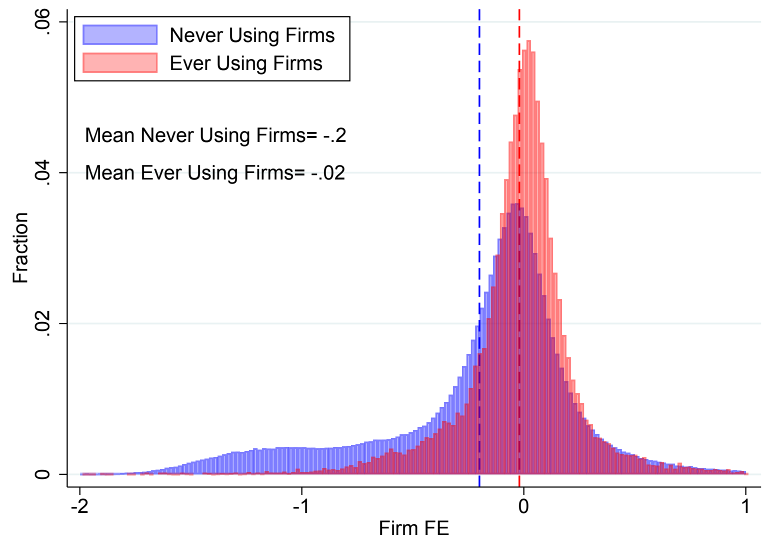
B. Evolution of Employment Including Posted Workers



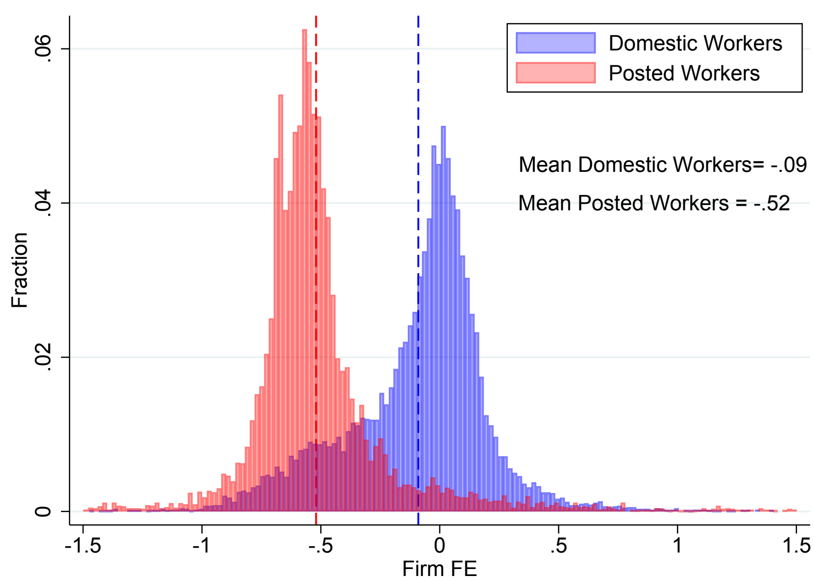
Notes: This figure studies how posting affects receiving firms and domestic workers in Belgium, one of the main receiving countries for posted workers. I use exhaustive administrative posting records of Belgian firms merged with administrative employment data to select the 11,796 firms that started using posted workers for the first time between 2014 and 2019. The figure plots the estimated event study coefficients γ_k from Equation (1.8) for the period 2008-2019, where the dependent variable is log employment and log wage rate (Panel A). Panel B compares the evolution of log overall employment (domestic and posted workers, red series) and log domestic employment (blue series) at receiving firms before and after the event. The event is defined as the first time a Belgian firm sources services to foreign posted employees. The coefficient of the year before the first posting use γ_{-1} is normalized to zero. The regressions include firm and three-digit sector $\times$ calendar year. γ_k compares the outcomes of receiving firms in event year k to the outcomes of future posting firms in the same narrowly defined sector in the year before their event. The vertical line represents 95% confidence intervals computed from robust standard errors clustered at the calendar year $\times$ province level. The estimates of γ_k using an alternative estimator for heterogenous treatment effects are reported in Figure A.21.

Figure 1.10: **Are Posted Workers Cheaper Than Domestic Workers?**

A. Firms Purchasing Posting Services Face Higher Domestic Labor Cost



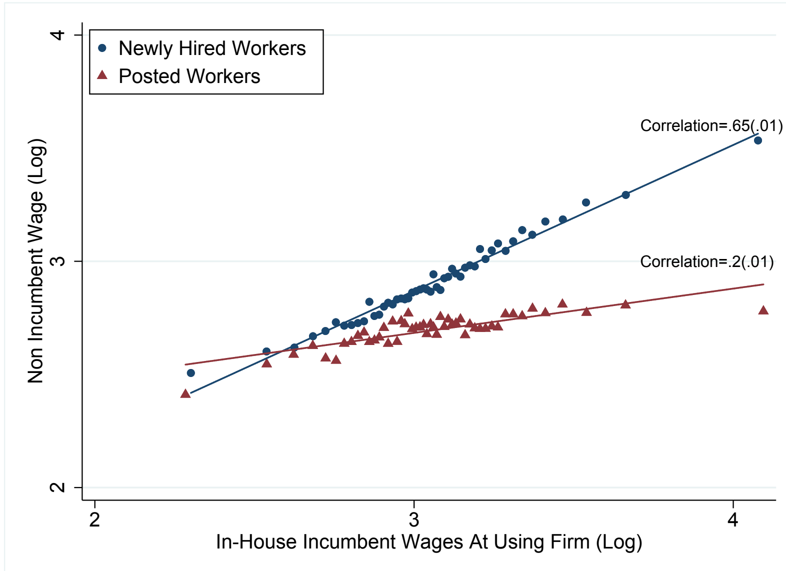
B. Posted Workers Receive Lower Workplace Wage Premia at Receiving Firms



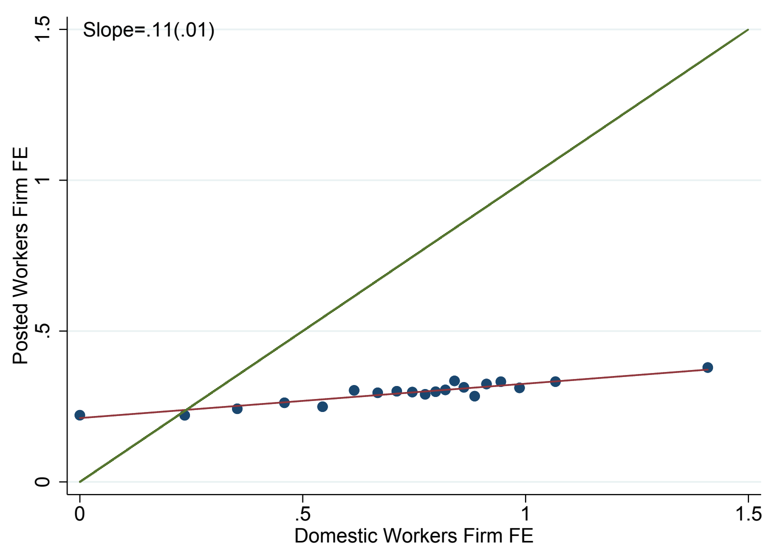
Notes: This figure compares posted workers' and domestic workers' wages in the second largest importer of posting services: France. I use the universe of mandatory posting declarations filed by foreign suppliers that send posted workers in the French territory (DPD/SIPSI dataset) to identify all posting contracts that started in 2017 and 2018, and to track the 23,332 French companies that have purchased a posting service in those years. For each posting contract, I observe, among other rich characteristics, the wage paid to the posted worker by their foreign employer, the hours of work linked to the posting mission, and the identifier of the French firm that purchased that mission. To obtain employment information on domestic workers, I use the linked employer-employee administrative dataset "DADS postes 2018" that covers all job spells of French employees in 2017 and 2018. I use the unique receiving firm identifier (SIREN) to link posted workers to French employees and end up with 19,138 French firms that purchased a posting contract at some point in 2017-2018 and for which at least one domestic job record exists in the 2017-2018 DADS postes. Panel A plots the histogram of workplace AKM effects for domestic workers, separately for firms that use or never use posting, based on Equation (1.9). Panel B plots workplace pay premia for domestic and posted workers estimated *within the sample of receiving firms only*, based on Equation (1.10). The mean wage premium for posted workers is -0.43 compared to the mean wage premium of domestic workers normalized to zero, suggesting a substantial wage penalty borne by posted workers.

Figure 1.11: **Surplus-Sharing Between Posted Workers and Receiving Firms**

A. Relationship Between Domestic Workers' and Posted Workers' Wages

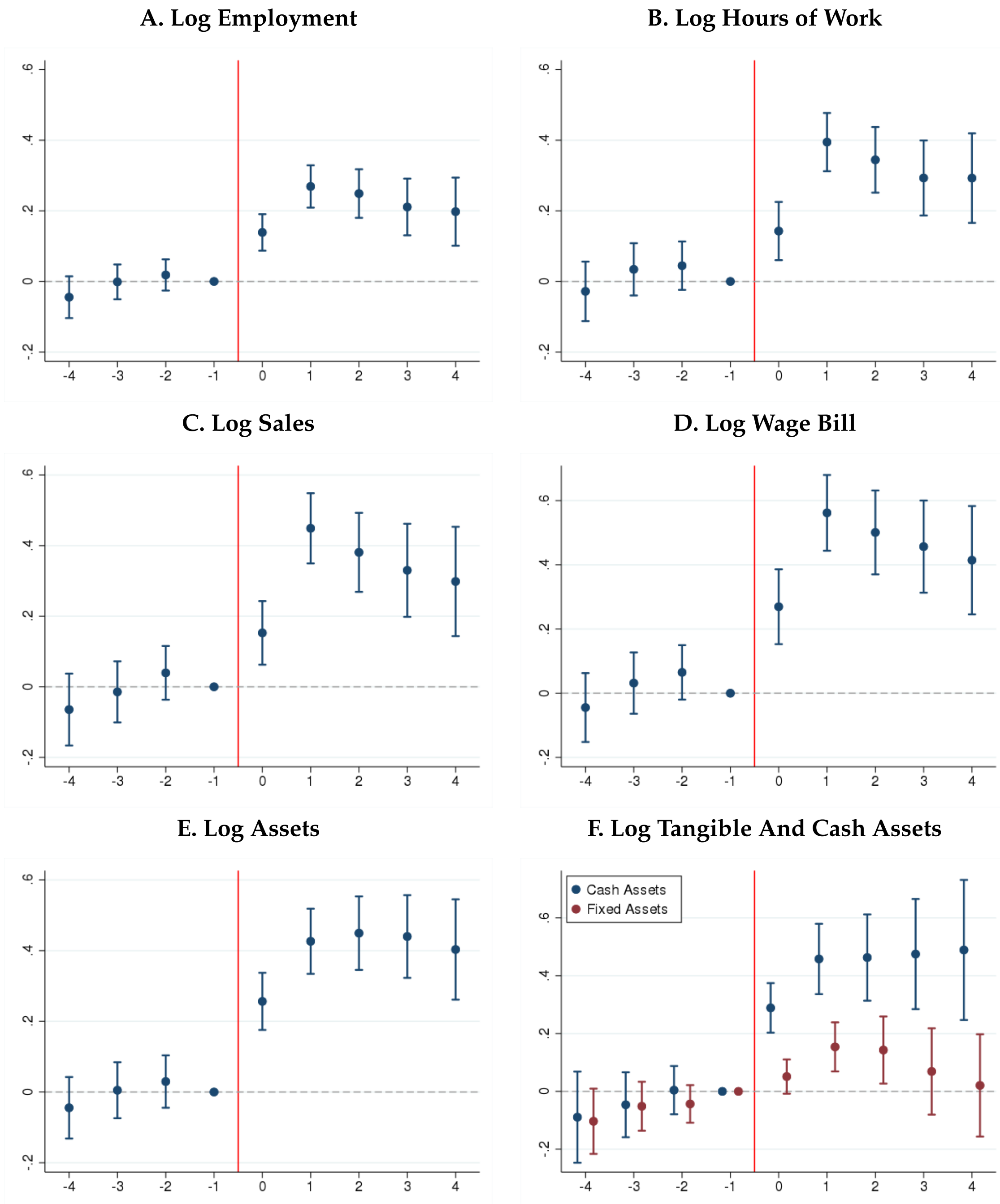


B. Firm-Level Pay Premia Sharing with Posted Workers



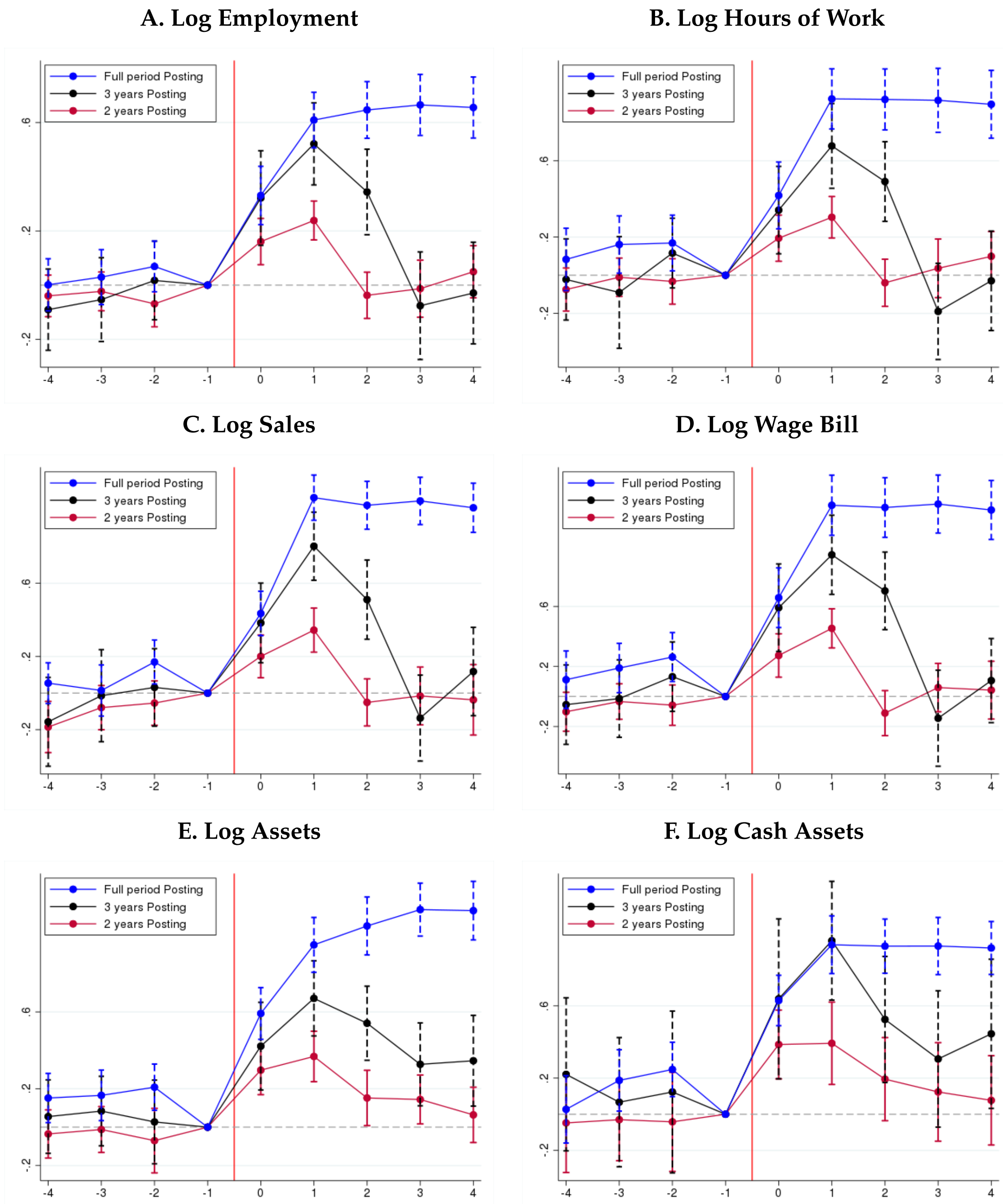
Notes: This figure compares posted and domestic workers' wage within a workplace in the second largest importer of posting services: France. I use the universe of mandatory posting declarations filed by foreign suppliers that send posted workers in the French territory (DPD/SIPSI dataset) to identify the 19,138 French firms that purchased a posting contract in 2017-2018 and for which at least one domestic job record exist in the 2017-2018 DADS postes dataset, a linked employer-employee dataset covering all job spells in France during that period. I can observe wages paid to French workers and posted workers at the same workplace in France. Panel A shows the relationship between incumbent, newly hired domestic, and posted workers' wages at the same workplace in 2018. It shows the binned scatterplot of log domestic incumbent workers' wage (x axis) against log domestic newly hired workers' wage (blue dots) and posted workers' wage (red dots) for receiving firms, residualized on five-digit sector fixed effects. Appendix shows similar pattern adding domestic temporary agency workers' wage in the comparison. Table 1.5 reports estimates of the raw wage penalty within a workplace borne by posted workers. Panel B shows the binned scatter plot of estimated AKM workplace effects for posted workers against estimated AKM workplace effects for incumbent domestic workers. For visualization, the fixed effects are normalized to zero in the lowest respective deciles, but the normalization does not affect the estimates of the slope. The red line in bottom panel corresponds to the regression described in Equation (1.11), while the green line depicts the 45-degree line.

Figure 1.12: **Sending Firms Expand When Starting to Provide Services Abroad**



Notes: This figure studies how posting affects sending firms located in Portugal, one of the main suppliers of posting services in Europe. I use exhaustive administrative tax records of Portuguese firms merged with administrative records of services performed in another EU country from 2006 to 2017 to select the 4,151 firms (with a median of more than three employees over the period) that start posting workers abroad for the first time between 2010 and 2015. The figure plots the estimated event study coefficients θ_k from Equation (1.13) for the period 2006-2017 where the dependent variable is log number of paid employees (Panel A), log total hours worked by employees (Panel B), log total sales (Panel C), log domestic sales (Panel D), log total assets (Panel E), and log wage bill (Panel F). The event is defined as the first time a Portuguese firm provides non-tradable services in another EU country. The coefficient of the year before the first posting θ_{-1} is normalized to zero. The regressions include firm and five-digit sector $\times$ calendar year $\times$ province fixed effects. θ_k compares the outcomes of posting firms in event year k to the outcomes of future posting firms in the same narrowly defined sector and province in the year before their event. The vertical line represents 95% confidence intervals computed from robust standard errors clustered at the calendar year $\times$ province level. The event study coefficients are reported in Table 1.6. The dataset and estimation sample are described in Appendix. The estimates of θ_k using de Chaisemartin and d'Haultfoeuille (2019) estimator for heterogeneous treatment effects and reporting pre-event median outcome levels are presented in Figure A.24.

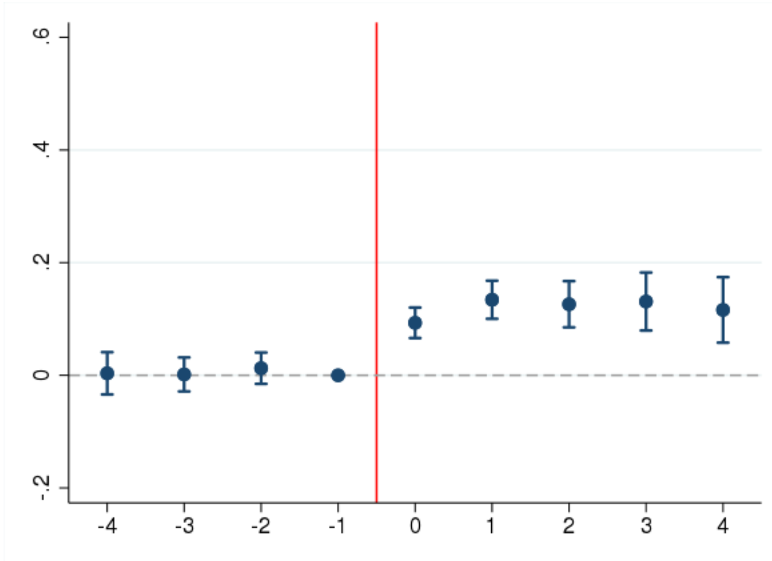
Figure 1.13: **Export-Mobility Gains Start and End With the Posting Mission**



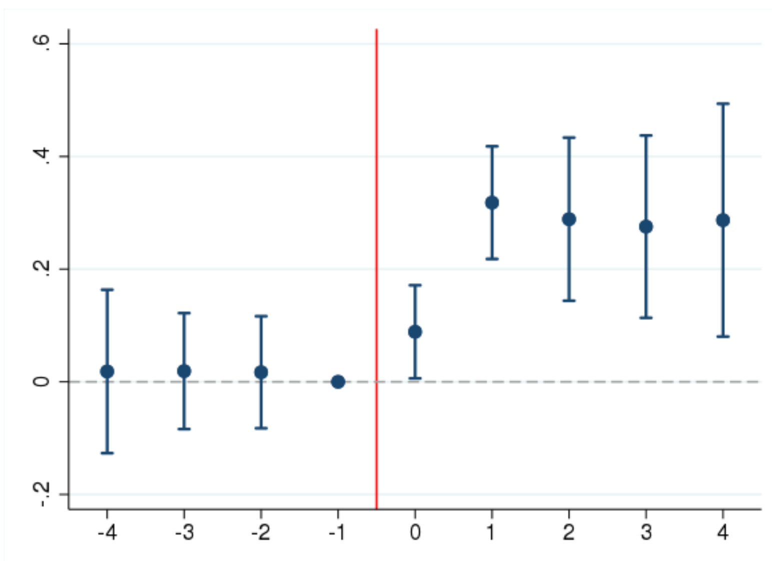
Notes: This figure studies how posting affects sending firms located in Portugal, one of the main suppliers of posting services in Europe. I use exhaustive administrative tax records of Portuguese firms merged with administrative records of services performed in another EU country from 2006 to 2017 to select the 4,151 firms (with a median of more than three employees over the period) that start posting workers abroad for the first time between 2010 and 2015. The figure plots the estimated event study coefficients θ_k from Equation (1.13) for the period 2006-2017 where the dependent variable is log number of paid employees (Panel A), log total hours worked by employees (Panel B), log total sales (Panel C), log domestic sales (Panel D), log total assets (Panel E), and log wage bill (Panel F). The event is defined as the first time a Portuguese firm provides non-tradable services in another EU country. The coefficient of the year before the first posting θ_{-1} is normalized to zero. The regressions include firm and five-digit sector $\times$ calendar year $\times$ province fixed effects. θ_k compares the outcomes of posting firms in event year k to the outcomes of future posting firms in the same narrowly defined sector and province in the year before their event. The vertical line represents 95% confidence intervals computed from robust standard errors clustered at the calendar year $\times$ province level. The event study coefficients are reported in Table 1.6. The dataset and estimation sample are described in Appendix.

Figure 1.14: **Surplus-Sharing Between Sending Firms and Posted Workers**

A. Wage Rate After Provision of Services Abroad



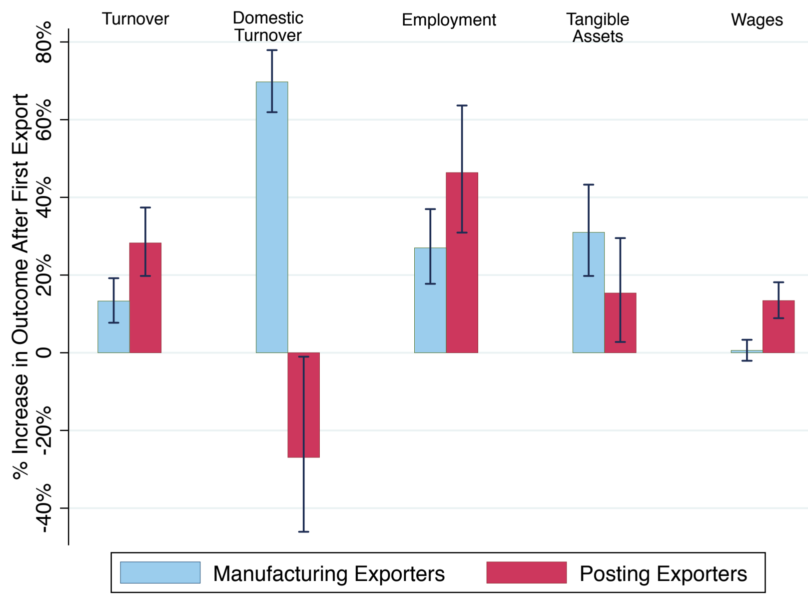
B. Profits After Provision of Services Abroad



Notes: This figure studies how posting affects sending firms located in Portugal, one of the main suppliers of posting services in Europe. I use exhaustive administrative tax records of Portuguese firms merged with administrative records of services performed in another EU country from 2006 to 2017 to select the 4,151 firms (with a median of more than three employees over the period) that start posting workers abroad for the first time between 2010 and 2015. The figure plots the estimated event study coefficients θ_k from Equation (1.13) for the period 2006-2017 where the dependent variable is log wage rate (Panel A) and log earnings before taxes (Panel B). The event is defined as the first time a Portuguese firm provides non-tradable services in another EU country. The coefficient of the year before the first posting θ_{-1} is normalized to zero. The regressions include firm and five-digit sector $\times$ calendar year $\times$ province fixed effects. θ_k compares the outcomes of posting firms in event year k to the outcomes of future posting firms in the same narrowly defined sector and province in the year before their event. The vertical line represents 95% confidence intervals computed from robust standard errors clustered at the calendar year $\times$ province level. The event study coefficients plotted in the figure are reported in Columns (1)-(2) of Table 1.7. The dataset and estimation sample are described in Appendix. Estimates accounting for heterogeneous treatment effects are presented in Figure A.35.

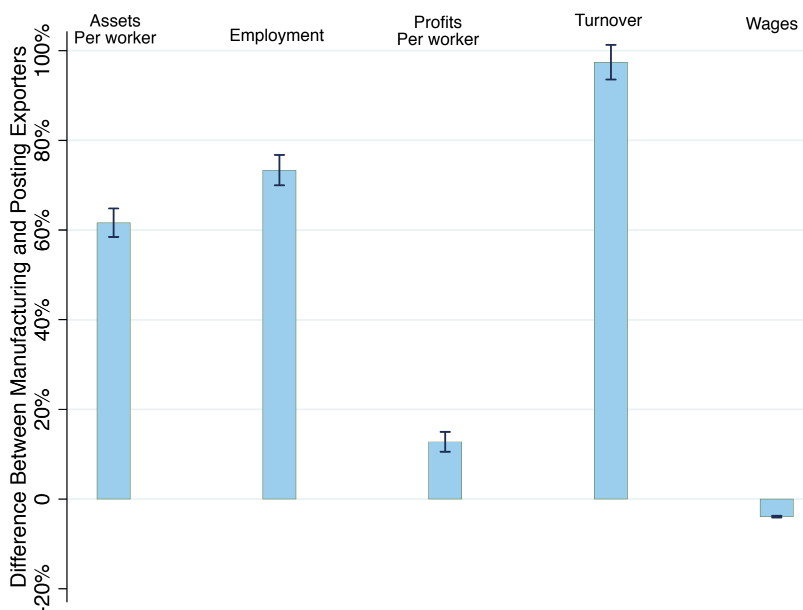
Figure 1.15: **Magnitude and Incidence of Firm-Level Export Gains in Posting Services and Manufacturing**

A. Firm-Level Export Gains in Posting Services Versus Manufacturing



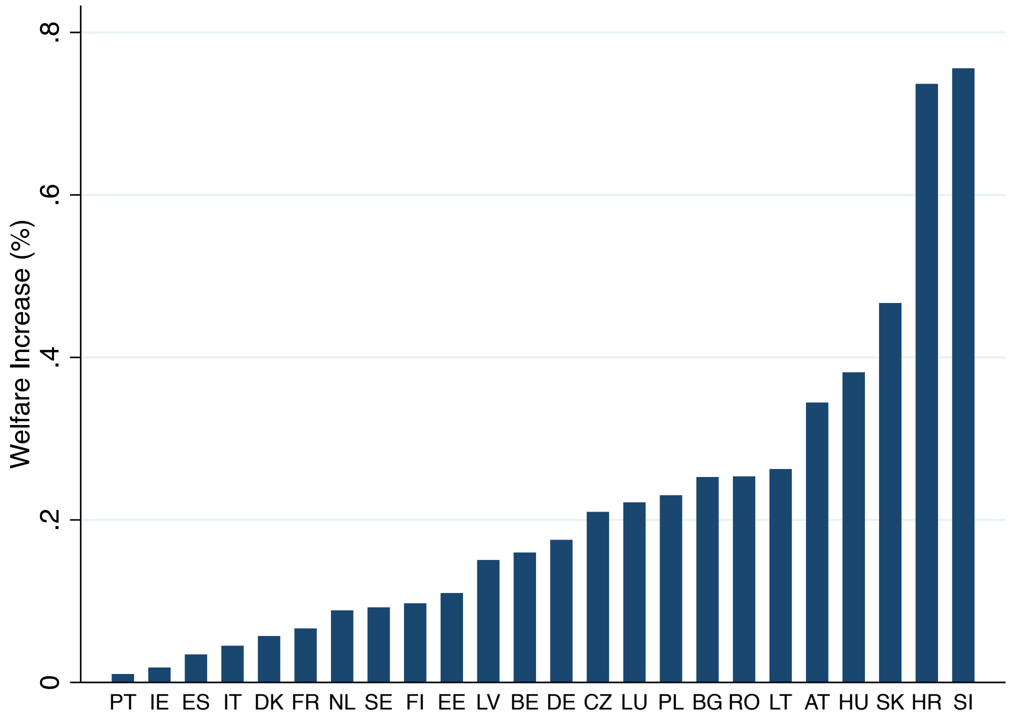
s

B. Differences Between Exporters of Manufacturing Goods and Posting Services



Notes: This figure summarizes the estimated firm-level gains from export events for firms located in Portugal, one of the main supplier of posting services in Europe. I use exhaustive administrative tax records of Portuguese firms merged with administrative records of services performed in another EU country, as well as goods exported abroad, from 2006 to 2017 to identify (i) the group of firms that start posting workers abroad for the first time between 2010 and 2015. (ii) the group of manufacturing firms that start exporting manufactured goods abroad for the first time during the same period. The top figure shows the average treatment effect $100(e^{\theta}-1)$ from Equation (1.13) estimated separately on these two samples. The treatment effect can be interpreted as the average percent increase in a firm outcome 2 years after that the firm starts exporting manufacturing goods (or posting services abroad), compared to the its pre-event level. The comparison of the entire dynamic path of effects between manfuacturing and posting exporters is displayed in Figure A.29. The bottom figure shows the average differences in firm-level outcomes between standard manufacturing exporters and posting firms, estimated from a regression described in the footnote of Table A.10. The coefficient can be interpreted as the percent difference for a given outcome for manufacturing exporters, as compared to firms exporting services through posted workers abroad.

Figure 1.16: **Model-Based Consumer Gains from Posting Liberalization after 2004**



Notes: This figure plots the distribution of aggregate consumer welfare gains following the lifting of mobility restrictions for employees posted for firms located in new member states, for each country in the European Union. The welfare effects of the change in posting policy accounts for general equilibrium effects and are based on Equation (1.20) and Equation (1.21). The model and calibrations use the Arkolakis et al. (2012) approach and the Dekle et al. (2008) exact hat algebra methodology. The model and calibrations only focus on sectors where trade in services through posting of workers occur. The structural theory-based policy shock $\hat{m}_{ij}$ is calibrated combining the reduced form effect of the liberalization estimated in Figure 1.4 (Table 1.1) with the structural posting elasticity θ in Table **??**. Using the estimates of the policy shock, the measure of current bilateral posting flows, and the measure of the structural posting elasticity, I numerically solve the system for changes in equilibrium wages and posting trade flows.

Table 1.1: **Causal Effect of the Liberalization on Posting service flows**

	(1)	(2)	(3)
4 years before liberalization	-.53		
	(.58)		
3 years before liberalization	-.05		
	(.31)		
2 years before liberalization	-.15		
	(.47)		
Year of liberalization	1.89***		
	(.35)		
1 year after liberalization	2.11***		
	(.49)		
2 years after liberalization	2.79***		
	(.53)		
3 years after liberalization	.88***		
	(.32)		
4 years after liberalization	1.08***		
	(.32)		
5 years after liberalization	.99***		
	(.35)		
6 years after liberalization	1.55***		
	(.37)		
7 years after liberalization	1.91***		
	(.47)		
8 years after liberalization	1.3***		
	(.63)		
Average Effect (β)		1.83***	.75***
		(.37)	(.13)
Observations	853	853	953
Origin-Destination FE	Yes	Yes	Yes
Destination $\times$ Year FE, Origin $\times$ Year FE	Yes	Yes	Yes
Estimation	Log	Log	PPML

Notes: *p<0.10, **p<0.05, ***p<0.01. The table summarizes the effects of lifting entry barriers for foreign suppliers' employees on within-EU posting flows. The dependent variable is the number of posting services from country i to country j at time t in log (Log) or levels (PPML). The identification strategy exploits the staggered timing of the exogenous liberalization reform across sending and receiving countries within the EU. The treatment is defined as country i gaining the right to post workers without reentry restrictions in country j at time t. The event study is restricted to receiving countries for which flows of posted workers can be observed before the liberalization in country-level datasets (Austria, Belgium, Germany, and France). Column (1) shows the dynamic effects following Equation (1.1) and shown in Figure 1.4. Columns (2) and (3) estimate average effects of liberalizing services exports mobility. In parentheses are robust standard errors clustered at the origin-destination level.

Table 1.2: **Causal Effect of Posting Exposure on Receiving Country Employment: Difference-in-Differences**

	Difference-in-Differences: Estimates of ζ Top 10 vs Bottom 40 Exposure, Before and After 2004						
Dependent Variable	Baseline	1990 Shares	2000 Shares	Distance NMS	Regional Exposure	Exposure Leave-Out	Top20 Bottom40
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Exposed Emp/pop (log)							
	-.0547***	-.0412***	-.0547***	-.0961***	-.0561***	-.755***	-.0401***
	(.007)	(.007)	(.007)	(.010)	(.007)	(.009)	(.007)
Observations	44	44	44	44	44	44	44
Exposed Emp/pop (% ppts)	-1.251***	-.65***	-1.251***	-.864***	-1.847***	-1.81***	-.872***
	(.177)	(.163)	(.177)	(.168)	(.617)	(.227)	(.149)
Observations	44	44	44	44	44	44	44
Total unemp (log)	.0520***	.039**	.0520***	.165***	.0628***	.105***	.0497***
	(.0138)	(.0140)	(.0138)	(.0113)	(.0160)	(.0142)	(.0117)
Observations	44	44	44	44	44	44	44
Unemp rate (% ppts)	.575***	.298**	.575***	1.51***	.653***	1.057***	.495***
	(.155)	(.110)	(.155)	(.129)	(.118)	(.016)	(.014)
Observations	44	44	44	44	44	44	44

Notes: *p<0.10, **p<0.05, ***p<0.01. Robust standard errors in parentheses. This table summarizes the effects of the 2004 posting liberalization shock on domestic employment in France. Employment of French workers does not include employment of workers posted in France, as these workers are employed by foreign firms. Estimates are based on the the difference-in-differences model described by Equation (1.4). Each reported coefficient is from a separate regression, and captures the differential evolution of domestic employment in French provinces with high and low exposure to posting, before and after the exogeneous supply shock of 2004. One observation is at the year-exposure level, from 1994 to 2015. To measure pre-reform exposure to imports of posting services, column (1) uses the baseline pre-reform spatial-industrial exposure per worker (Equation (1.2)). Column (3) uses 1990 industry shares, column (3) uses 2000 industry shares, column (4) uses geographic distance to NMS countries that gain access to the French market in 2004, column (4) uses region-level exposure per worker and column (5) implements a "leave-out" correction as described in the text. Each coefficient can be interpereted as the differential evolution of the dependent variable in provinces with top versus bottom exposure to the liberalization, after the liberalization as compared to before.

Table 1.3: **Causal Effect of Posting Exposure on Receiving Country Employment: 2SLS Model**

Panel A. Dependent Variable: Change in exposed employment/pop, 2003-2015 (%pts)

	Post-reform (2003-2015)					Pre-reform, Falsification Test	
						1993-2000	2000-2003
	OLS	RF	IV	IV	IV	IV	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Δ log Posting Imports/worker	-.638***	-.462***	-1.604***	-.983***	-.983***	.229	.144
	(.231)	(.117)	(.338)	(.272)	(.245)	(.444)	(.188)
Observations	94	94	94	94	94	94	94
Fstat			19.49	25.39	25.39	19.37	19.47
AR			15.35	16.14	12.1		

Panel B. Dependent Variable:100 × log change in population counts, 2003-2015

	Exposed Emp	Adult Pop	Sheltered Emp	Unemployment/pop
	(8)	(9)	(10)	(11)
Δ log Posting Imports/worker	-3.83**	.807	.754	.427**
	(1.76)	(1.42)	(2.81)	(.176)
Observations	94	94	94	94

Notes: *p<0.10, **p<0.05, ***p<0.01. Robust standard errors in parentheses. The table shows the estimates of the IV model relating local domestic employment changes from 2003 to 2015 with changes in posting exposure after the liberalization of 2004, which is measured as imports of posting services per pre-reform total number of worker, in log. To account for endogeneity in posting inflows after the liberalization, imports of posting services over 2005-2015 is instrumented by the 2003 province exposure to posting. The top panel uses the 2003-2015 change in the share of French working age population employed in exposed sector as a dependent variable, and is measured in percentage points. The regressor is the log of a province posting imports after the reform in total pre-reform employment. Column (2) shows the reduced form relationship between the dependent variable and the instrument. Column (4) controls for the initial share of a province employment in exposed sectors. Column (5), (6) and (7) show placebo estimates of 2003-2015 local import exposure on lagged employment growth in exposed sectors. The bottom panel uses log points (100 times log changes) as the dependent variable, for exposed sectors, sheltered service sectors (no posting imports), total unemployment, and working age population. All columns except column (5), (9), (11) and (13) are weighted by the the province adult population at the beginning of the period. More details are provided in the text. Robustness to the specification column (3) are displayed in Table A.7 and Table A.9. Figure A.16 repeats the specification in column (3) deleting one observation at a time. The first stage relationship between pre-liberalization exposure and posting imports after the reform is detailed in Table A.6. More details are provided in the text of Section 3.

Table 1.4: **Dynamic of Receiving Firms Employment and Wages After First Posting Use Event**

	(1)	(2)	(3)	(4)
Dependent Variable (in log)	Total Employment	Wage Rate	Blue Collar Workers	Other Workers
4 years before event	.02326*	.0080**	.0268	-.0257
	(.0123)	(.0039)	(.01475)	(.2080)
3 years before event	.0184**	.0060**	.0162	-.0697
	(.0091)	(.0030)	(.0112)	(.1941)
2 years before event	.0073	.0037	.0154	.2889
	(.0058)	(.0024)	(.0073)	(.4657)
Year of event	-.0158**	-.0005	-.0219***	-.2210
	(.0062)	(.0022)	(.0075)	(.3087)
1 year after event	-.0288***	-.0040	-.0423***	-.5621
	(.0103)	(.0033)	(.0128)	(.5307)
2 years after event	-.0711***	-.0086*	-.0596***	-.7750
	(.0104)	(.0045)	(.0180)	(.7603)
3 years after event	-.1219***	-.0084	-.1031***	-1.362
	(.0154)	(.0058)	(.0242)	(1.012)
4 years after event	-.1752***	-.0093	-.1336***	-.9746
	(.0262)	(.0075)	(.0310)	(1.291)
Firm FE	Yes	Yes	Yes	Yes
Year×3DSect	Yes	Yes	Yes	Yes
Never Using Firms	No	No	No	No
# of Observations	108,386	107,973	68,718	90,146

Notes: *p<0.10, **p<0.05, ***p<0.01. This table reports the estimates of domestic employment responses to the use of posting services by Belgian firms. The estimates are based on Equation (1.8).

Table 1.5: **Posting Employment Pay Penalty**

	Outcome: Log Wage			
	(1)	(2)	(3)	(4)
Posting Arrangement	-.32***	-.30***	-.30***	-.34***
	(.002)	(.004)	(.004)	(.003)
Temp Employment Arrangement				-.12***
				(.001)
Firm FE	Yes	Yes	Yes	Yes
Polynomial Age	No	Yes	Yes	Yes
Log Hours of Work	No	Yes	Yes	Yes
Year Fe	Yes	Yes	No	Yes
Observations	13,144,061	13,144,045	13,144,045	13,144,045

Notes: The table compares posted and domestic workers' wage *within a workplace* in the second largest importer of posting services: France. I use the universe of mandatory posting declarations filed by foreign suppliers that send posted workers in the French territory (DPD/SIPSI dataset) to identify the 19,138 French firms that purchased a posting contract at some point in 2017-2018 and for which at least one domestic job record exist in the 2017-2018 DADS postes dataset, a linked employer-employee dataset covering all job spells in France during that period. Merging the DADS with the posting registry, I can observe wages paid to French workers (reported in DADS by French employer) and posted workers (reported in DPD/SIPSI by foreign supplier) at the same workplace in France. For the sample of receiving firms in 2017-2018, I regress workers' log wage on an indicator equal to one if the workers is in a posting arrangement, controlling for firm fix effects, cubic age, and number of hours worked.

Table 1.6: **Sending Firms' Expansion Around the First Posting Event**

Dependent Variable (in log)	(1) Turnover	(2) Wage Bill	(3) Hours Worked	(4) Employees	(5) Total Assets
4 years before event	-0.0644	-0.0446	-0.0280	-0.0446	-0.0446
	(.0518)	(.0546)	(.0428)	(.0301)	(.0442)
3 years before event	-0.0144	.0316	.0343	-0.00121	.00508
	(.0440)	(.0486)	(.0376)	(.0250)	(.0402)
2 years before event	.0395	.0649	.0447	.0184	.0296
	(.0387)	(.0431)	(.0349)	(.0225)	(.0377)
Year of event	.153***	.269***	.143***	.139***	.256***
	(.0458)	(.0593)	(.0419)	(.0263)	(.0411)
1 year after event	.449***	.562***	.395***	.269***	.426***
	(.0506)	(.0600)	(.0419)	(.0305)	(.0469)
2 years after event	.381***	.501***	.344***	.249***	.449***
	(.0569)	(.0664)	(.0473)	(.0350)	(.0529)
3 years after event	.330***	.457***	0.293***	.211***	.440***
	(.0670)	(.0730)	(.0540)	(.0408)	(.0595)
4 years after event	0.298***	0.414***	.293***	.198***	.403***
	(.0787)	(.0858)	(.0645)	(.0490)	(.0722)
Firm FE	Yes	Yes	Yes	Yes	Yes
Year×5DSect×Prov FE	Yes	Yes	Yes	Yes	Yes
Never Posting Firms	No	No	No	No	No
# of Observations	29,754	29,971	29,880	29,972	30,851

Notes: *p<0.10, **p<0.05, ***p<0.01. The table reports the event study estimates from the empirical specification described by Equation (1.13) for the period 2006-2017, focusing on the 4,151 firms that post workers for the first time between 2010 and 2015. The regressions include firms and five-digit industry × province × year fixed effects. Robust standard errors are clustered at the event year × province level to account for spatial autocorrelation of errors terms. The estimation sample is described in detail in Appendix.

Table 1.7: **Dynamic Effects of First Posting on Firms' Wages and Profits**

	(1)	(2)	(3)	(4))
Dependent Variable (in log)	Wage Rate	Profits	Wage Rate	Profit
4 years before event	.00996	-0.0183	.00354	.0184
	(.0161)	(.0545)	(.0191)	(.0737)
3 years before event	.00455	.0231	.00154	.0190
	(.0154)	(.0411)	(.0153)	(.0523)
2 years before event	.0129	.0284	.0126	.0169
	(.0156)	(.0379)	(.0141)	(.0506)
Year of event	.0834***	.0932**	.0932***	.0887**
	(.0200)	(.0429)	(.0138)	(.0420)
1 year after event	.119***	.304***	.134***	.318***
	(.0213)	(.0478)	(.0172)	(.0508)
2 years after event	.102***	.266***	.126***	.289***
	(.0201)	(.0438)	(.0208)	(.0736)
3 years after event	.106***	.256***	.131***	.275***
	(.0198)	(.0479)	(.0262)	(.0823)
4 years after event	.0835***	.255***	.116***	.287***
	(.0185)	(.0465)	(.0296)	(.105)
Firm FE	Yes	Yes	Yes	Yes
Year×5DSect×Prov FE	Yes	Yes	Yes	Yes
Never Posting Firms	Yes	Yes	No	No
# of Observations	235,471	167,496	29,880	23,118

Notes: *p<0.10, **p<0.05, ***p<0.01. The table reports the event study estimates from the empirical specification described by Equation (1.13) for the period 2006-2017. The estimation sample is restricted to the 4,151 firms that post workers for the first time between 2010 and 2015 in Columns (3)-(4), while Columns (1)-(2) use the 28,803 firms that never post workers over the period as an additional control group. The regressions include firms and five-digit industry × province × year fixed effects. Robust standard errors are clustered at the event-year × province level to account for spatial autocorrelation of errors terms. The estimation sample is described in detail in Appendix.

Table 1.8: **Model-Based Welfare Gains in the Service Sector**

	Consumer Gains in Services After Policy Shock (%)	
Member State	NMS Liberalization	No Autarky
Austria	.35	1.9
Belgium	.16	4.3
Bulgaria	.26	.62
Czech Republic	.21	.75
Germany	.18	.81
Denmark	.05	.40
Estonia	.45	.90
Spain	.03	.42
Finland	.12	.52
France	.07	.85
Croatia	.76	1.3
Hungary	.39	.80
Ireland	.02	.15
Italy	.04	.30
Lithuania	.27	.42
Luxembourg	.22	6.8
Latvia	.15	.5
Netherlands	.09	1.1
Poland	.25	.42
Portugal	.01	.91
Romania	.27	.67
Sweden	.09	.52
Slovenia	.78	1.2
Slovakia	.48	.74

Notes: *p<0.10, **p<0.05, ***p<0.01. This table summarizes the average and median welfare gains from lifting posting restrictions, as explained in the text. The calibration accounts for general equilibrium effects and is based on equation (1.20) and equation (1.21).

Chapter 2

Tax Competition and the Geography of Trade-in-Services

2.1 Introduction

Tax rates differ substantially across countries and across locations within countries. An important question is whether people choose locations in response to these tax differentials, leading to tax competition across countries. Due to globalization, it has become increasingly important to pay attention to mobility responses when designing tax policy.

This paper studies a novel channel through which tax differentials affect the international mobility of workers in a globalized world: trade-in-services. When countries trade, firms can send their employees abroad to supply services locally. Using Europe as a laboratory, I show that labor tax rules set in trade treaties affect the international mobility of workers through trade-in-services. This novel trade-migration response to taxes carries two central implications for tax and trade policy: (i) tax-induced international mobility of workers is larger than previously thought and (ii) tax competition matters for comparative advantages in trade-in-services.

So far, the empirical literature on tax competition and international factor mobility has focused on international migration responses to taxes at the top of income distribution (Kleven et al. (2014),Kleven et al. (2013),Akcigit et al. (2016),Muñoz (2019a), Kleven et al. (2020)), or the effects of capital taxation on multinational corporations and international capital mobility (Gordon and Hines (2002), Devereux and Griffith (2003), Griffith et al. (2010)). While trade integration is rising, very little work has been devoted to understanding the interaction between international trade and tax policy. Most studies focus on the role of tariffs for international trade (Bagwell and Staiger (1999), Head and Mayer (2014)), while direct evidence on the trade implications of tax competition is scarce. At the same time, the literature focusing on the design of tax policy in a globalized world has so far ignored responses to personal taxes through international trade trade. This paper takes a first step to fill this gap by studying trade-migration responses to taxes in the

European labor market.

The European Union offers three important advantages for the study of international trade-migration responses to taxation. First, the European Union has the oldest and most liberal trade-migration scheme in the world, the European posting policy: trade-in-services through internationally mobile workers is therefore quantitatively large in Europe (Muñoz (2021)). This makes the EU a valuable and visible laboratory to study the implications of tax competition for trade-in-services through mobile workers. Hence, this study likely provides an upper bound on the international trade-migration response to taxes for other areas of the world. Obtaining an upper bound is crucial to gauge the potential importance of this policy question, especially as labor markets become more internationally integrated, and other trade-migration schemes have been implemented in many recent trade agreements.

Second, extensive data on the international mobility of service suppliers can be collected for a long time period, and for all European countries. In this paper, I use administrative datasets that allows me to track the cross-border supply of services by "posted workers" in all European member states since 2009. I combine this dataset with exhaustive data on payroll taxes, minimum wages and other labor market regulations that apply to international suppliers of services in Europe. This dataset allow me to overcome two important measurement challenges usually faced by the public finance and trade literature. To estimate standard international mobility responses to taxes, information on migration patterns combined with precise measures of tax rates in different locations is hard to come by, due to the lack of administrative cross-country registries (Kleven, Landais, Munoz, and Stantcheva (2020)). Similarly, the paucity of empirical studies on trade in services responsiveness to policy changes can be traced to the lack of reliable micro data on those transactions, as services are absent from usual customs-based measures of trade flows (Francois and Hoekman (2010)). By collecting data on posted workers, I avail myself of novel administrative records of service trade and the international mobility of workers, overcoming these two challenges simultaneously.

Third, I can exploit many sources of variation in both tax policy and labor market regulation to identify the effect of taxation on trade-migration flows in the European Union: (i) The European posting policy enacted an "origin-based" tax treatment of trade-migration flows that generates origin-specific labor cost variations within a receiving country (ii) Payroll tax rates vary aross countries over time (iii) Preferential tax schemes and regulations for posted workers have been implemented in some countries and some sectors. Together, these policy changes create compelling quasi-experimental variation to identify causal impacts of taxation on the geography of trade-in-services and the international mobility of workers.

I first set out a theoretical model of taxation and cross-border supply of services by mobile workers. In a globalized world, firms in each country can send workers abroad to supply services, but their costs are affected by payroll tax rules and labor market regulations applying to trade-migration flows. The theoretical framework illuminates the role of tax policy for the spatial allocation of workers and services: tax rules for posted workers jointly determine the international mobility of employees and the geography of trade-in-services. When tax treaties exempt trade-migration flows from payroll taxes in destination countries, trade-migration flows are decreasing in the level of taxes in the exporting country, and increasing in the level of taxes in the importing country. The model defines one parameter of interest: the elasticity of trade-migration flows with respect to the employers' cost of internationally mobile workers.

I then present reduced-form graphical evidence showing clear effects of taxation on trade and migration flows. Because of payroll tax exemptions granted to international suppliers of services, workers posted from low-tax countries are cheaper to hire than domestic workers at the same workplace. I start by considering the relationship between employers' labor cost differentials and bilateral posting flows between two countries. I find a strong positive correlation between payroll tax differences and trade-migration flows. The implied elasticity of the number of posted workers with respect to payroll tax differentials is large and statistically significant, with a correlation of 0.6. In steady-state, tax differentials matter for the geography of trade-in-services and for the international mobility flows of workers within Europe: low-tax countries are net exporters of posted workers while high-tax countries are net importers of services supplied by mobile workers.

I then turn to quasi-experimental evidence of international trade-migration responses to large and exogenous reforms in employers' payroll taxes in sending and receiving countries. I study two quasi-natural experiments: (i) a large reform in employers' social security contributions in one of the largest sending countries (Slovenia), (ii) a large reform in employers' social security contributions in one of the largest receiving countries (Belgium). For each country-specific tax reform in the origin (respectively destination) country, I build a control origin (respectively destination) country using neighbouring countries or the synthetic control method of Abadie et al. (2010b). I show clear graphical evidence that international trade-migration flows respond to taxation. The number of workers sent from Slovenia increases compared to the number of workers from comparison countries after that Slovenia decreases taxes for its workers. Similarly, the number of workers sent to Belgium diverges from the number of posted workers in the comparison country immediately after the payroll tax cut in Belgium. The corresponding reduced-form elasticities of trade-migration flows with respect to employers' payroll cost are large, and lie between 1.7 and 3.1.

Next, I turn to quasi-experimental evidence exploiting the implementation of preferential tax schemes for posted workers *within* receiving and sending countries. I study two quasi-natural experiments: (i) the repeal of payroll tax exemptions for temporary employment agency workers sent from Luxembourg (sending country) and (ii) the implementation of a posting allowance for manufacturing workers posted to Germany (receiving country). For each country-specific preferential scheme, I build a control group using trade-migration flows in sectors and countries not treated by the reform. This additional source of variation allows me to filter all country-by-year shocks that occur simultaneously to the tax reform in either the origin or receiving country. I show compelling graphical evidence of international trade-migration responses to tax changes. In Luxembourg, the number of workers posted abroad diverges from the number of workers supplying services domestically immediately after the increase in payroll tax rates for workers posted abroad. In the control sector, posted and non-posted employment evolve similarly before and after the reform, indicating that the posting-specific tax change explains the change in trade-migration flows. The triple differences model, controlling for origin-year and sector-year fixed effects, yields an implied reduced-form elasticity with respect to payroll taxes of 1.3. Turning to the German experiment, the number of foreign workers in the treated sector diverges from the number of foreign workers in the control sector after the introduction of an additional sector-specific posting allowance. In the control neighbouring country, the number of posted workers in the treated and control sector evolve similarly before and after the reform, indicating that the posting-specific cost reform primarily explains the change in trade-migration flows. The triple differences model, controlling for destination-year and sector-year fixed effects, yields an implied reduced-form elasticity of 1.27.

Finally, I present results from theory-based gravity regressions using all sources of variation in payroll tax rates and labor market regulations across countries and years. The coefficients from the gravity models allow me to estimate trade-migration elasticities, controlling for all the structural parameters emphasized by the model. When including the full set of fixed-effects that are consistent with theory, the estimated coefficients can be interpreted as structural parameters. Consistent with my reduced form results, I find strong international trade-migration responses to taxes. The elasticity of trade-migration flows with respect to the total employers' cost of internationally mobile workers is above one, with a median estimate of 1.1. Benchmarking those findings with studies using similar structural gravity approaches with different datasets and policy variations, the trade-migration elasticity is four times lower than the elasticity of standard trade flows (Head and Mayer (2014)) and is above the international elasticity of standard immigration flows within the EU (Caliendo et al. (2017)). Responsiveness to trade costs is lower for exports of posting services than for exports of goods, suggesting that trading workers is more costly than trading machines. At the same time, trade-migration exhibits more responsiveness compared to standard immigration flows, suggesting that the international mobility of workers intermediated by suppliers of services alleviates some of the usual migration frictions.

I use this theory-consistent estimate of the trade-migration elasticity to quantify the implications of changing current tax provisions in European trade treaties. I show that enforcing equal payroll tax rates in European trade policy would decrease current trade-migration flows by a first order effect of 30%, and would mostly affect exports of suppliers of services from low-cost countries. The reform has two effects on tax revenues collected on internationally mobile workers. On the one hand, the reform mechancially increases the rates applying to trade-migration flows. On the other hand, the equal-tax reform decreases trade-migration flows in the EU because of behavioral responses to taxes. Because elasticities are large and above one, the mechanical increase in tax rates on the posted workers' tax base does not fully compensate the decrease in trade-in-services within the EU. This back of the envelope computation provides a basis for discussing the cross-country transfers that would compensate the end of tax competition for trade-in-services through posted workers.

The first contribution of this paper is to shed light on a novel behavioral response to taxation in an open economy. More specifically, I show that trade liberalization in services increases the overall international mobility responses to taxes through the trade-migration channel. This matters to quantify the overall efficiency burden of taxation in a globalized world (Saez et al. (2012)). Focusing on standard "immigration" responses to taxation (Lehmann et al. (2014), Kleven et al. (2013), Kleven et al. (2014), Akcigit et al. (2016)) leads us to omit large mobility responses to taxes through trade. When the government increases tax rates, collected tax revenue is affected through out-migration of residents (the standard migration response to taxes), but also through lower service-migration exports (the trade-migration response to taxes). This novel channel through which tax differentials affect the international mobility of workers in a globalized world is likely to matter not only conceptually, but also quantitatively: (i) international mobility of workers through trade-in-services is twice larger than standard immigration in Europe (Muñoz (2021)) (ii) trade-migration responsiveness to taxes is larger than for usual international migration. Those estimates also provides us with a lower-bound of trade-migration responses to tax competition *within* countries where interstate trade is liberalized while taxes and labor market regulations vary across space. Supply of services through mobile employees is yet to be quantified within the U.S due to the lack of relevant data, but the European experiment suggests that those flows could be very large, especially as suppliers of services tend to be increasingly clustered in the U.S territory (Hsieh and Rossi-Hansberg (2019)). My findings suggest that in the absence of prevailing cost or wage policies, suppliers of services locate in states with low level of taxes and minimum wages and send their employees to higher-tax states to supply services there.

The second contribution of this paper is to provide well estimated parameters that are central to address policy-relevant questions for various literatures. The elasticity of the number of foreign workers with respect to taxes can first be used by the public finance literature to inform optimal taxation and related tax competition issues (Kleven et al. (2020), Lehmann et al. (2014)). The elasticity of trade-migration flows with respect to taxes can also be used by trade economists to perform a wide-range of counterfactual experiments (Head and Mayer (2014), Head and Mayer (2021)). While services account for more than 74% of GDP in high-income countries, Francois and Hoekman (2010) emphasize the lack of well-estimated trade elasticities for services due to two measurement challenges. Services are absent from usual custom-based datasets and are regulated by non-tariffs barriers that can hardly be converted into ad-valorem cost changes. I overcome those two challenges and propose theory-based estimates of the trade elasticity for services that can be used by most trade models to inform the welfare and trade effects of policy shocks in the service sector (Costinot and Rodríguez-Clare (2014); Arkolakis et al. (2012)). Those findings matter because my estimates are substantially smaller than usual trade elasticities for goods, thus providing a key paramter to inform current policy discussions of further trade liberalization in services. Trade-in-services through mobile workers is thus not only affected by different policies compared to standard trade but also characterized by different responsiveness to these different policies.

The last contribution of this paper is to document a novel source for countries' comparative advantages in services. Some papers have focused on the role of domestic labor cost policies on firms' exports: for instance Gan et al. (2016) look at the effects of minimum wages on Chinese exporters while Malgouyres and Mayer (2018) focus on the effects of a tax break on French exporters. There is also a large literature on the effects of capital taxation on foreign direct investments (Gordon and Hines (2002), Devereux and Griffith (2003), Griffith et al. (2010)). Closely related to my findings, there is a theoretical literature that focuses on terms-of-trade and trade tariffs, showing that countries have an incentive to use tariffs to manipulate their terms-of-trade (Bagwell and Staiger (1999)) or to attract foreign firms (Ossa (2011)). I complete those findings by providing causal evidence that international differences in tax rates and regulations matter for the geography of trade-in-services: labor cost competition is a way to gain market shares in the service sector.

2.2 Context and Data

2.2.1 International Mobility Through Trade-in-Services in Europe

The focus of this paper is to show that in a globalized world, tax differentials affect the international mobility of workers through an additional channel: trade-in-services. First documented in Muñoz (2021), posting policies broadly consist in temporary contracts performed locally by foreign firms. To export services, foreign suppliers temporarily send their employees abroad to perform a service mission. Export of services through posted workers is called *mode 4 service supply* in the WTO general framework for trade in services. Posting policies regulating these novel trade-migration flows have thus been discussed in most of recent trade agreements, and are systematically negotiated in multilateral GATS (*general agreements on trade in services*). Because of the intersection between foreign services provision and consumer location that is absent in standard trade, posting policies imply that receiving countries choose what taxes, entry, and regulations apply to posted workers in their territory. This intersection creates a unique opportunity to study how tax differentials can shape simultaneously the geography of trade-in-services and the spatial allocation of workers.

This paper takes a first step at studying trade-migration responses to taxes using the European labor market as a laboratory. Established in 1959, the EU posting policy allows firms located in the territory of one member state to send their workers in any other member state to perform a temporary service mission, without having to open an establishment in that country. Receiving countries have no right to refuse the foreign intervention of supplier of services in their territory, but can control that the posting mission follows the rules established by the EU posting policy.

The posting policy determines what taxes and regulations apply to these novel migration trade flows in the receiving country. The European posting policy enacted an "origin-based" tax treatment of trade-migration flows. Receiving countries must grant large exemptions to posted workers: sending firms only have to pay payroll taxes in the sending country. While the posting policy is meant to regulate "temporary" services provision between member states, there is not a legal limitation to posting mission. The sending firm must, however, have a "substantial" activity in the country of establishment. Exemptions from receiving payroll taxes are also granted for a limited duration: 12 months until 2010, 24 months from 2010-2020, and 18 months since 2020. To combat social dumping and prevent distortion of competition, the EU provided posted workers with a legal right to the basic minimum rights and conditions in receiving countries. Since 1996, foreign firms must pay an additional posting allowance to send workers in some sectors and some countries where a legal minimum wage is in place. Since 2020, posted workers must receive the same pay as domestic employees at the receiving firm and are covered by some collective labor agreements. Finally, posted workers remain resident of their origin country and therefore pay their income taxes at home, unlike standard immigrants. To summarize, when firms in country A send workers to country B to supply services locally, payroll taxes, income taxes and corporate taxes are collected in country A.

The European labor market provides a visible and transparent laboratory to study the international trade-migration responses to taxes. First, the cross-border supply of services is fully liberalized within the EU, making it a valuable laboratory to study the implications of tax competition for trade-in-services through mobile employees. Second, extensive data on the international mobility of service suppliers can be collected for a long time period, and for all European countries. Third, the European setting created many sources of variation in both tax policy and labor market regulation that are key to identify the effect of taxation on trade-migration flows.

If posting of workers is a first-order phenomenon in Europe (Muñoz (2021) documents that trade-migration flows are twice larger than standard immigration within the EU), understanding trade-migration responses to taxes also matters for other contexts. First, trade-migration schemes have been recently discussed and implemented in many areas of the world, from the Asia Pacific Economic Cooperation (APEC) to U.S.-Mexico-Canada Agreement (USMCA), the Economic Community of West African States (ECOWAS) or within MERCOSUR. As outlined by Bhagwati et al. (2004), those trade-migration schemes are usually controversial because they require to bring national tax and labor market policies into the fold of international trade discussions. Second, trade-migration responses to taxes and labor market regulations can also pose important challenges in countries where those policies vary across locations. When interstate trade is liberalized, my findings suggest that suppliers of services locate in low-tax and low-minimum wage areas to supply services to higher-tax areas, thereby creating tax competition incentives across locations.

2.2.2 Data on Trade-Migration Flows and Labor Cost

A. Posted Workers

I measure trade-migration flows of posted workers in Europe with administrative social security certificates E101/A1 issued for each posting mission within the EU. This certificate is a mandatory document that posted workers must hold during their mission to prove their affiliation to their sending country's social security system.[1] This document being compulsory for health insurance coverage during the posting mission, the reliability of the data is high. The posting certificates are issued by sending countries and are linked to the work mission rather than to the worker: a unique worker may be linked to several posting forms. One E101/A1 form identifies simultaneously a flow of a worker moving abroad and a service mission export.

Each year, the European Commission collects information on all posting certificates issued within the European Union. I obtained all E101/A1 posting forms issued and received by 25 European member states from 2005 to 2017 from the European Commission. The countries are Austria, Belgium, Bulgaria, Czech Republic, Germany, Denmark, Estonia, Spain, Finland, France, Croatia, Hungary, Ireland, Italy, Lithuania, Luxembourg, Latvia, Netherlands, Poland, Portugal, Romania, Sweden, Slovenia, Slovakia, United Kingdom. The final dataset allows me to trace the trade-migration patterns of workers for each origin and

[1] The absence of the E101/A1 social security forms implies a fine for services supplier and receiving firms and can lead social security contributions to be paid in both sending and receiving countries. The E101/A1 only concerns trade-related mobility within the EU and does not apply to postings from outside the EU. As these flows are very heavily regulated, they are, however, very small, as shown in the rest of this paper.

destination country each year, aggregated at the bilateral level. The dataset covers the universe of workers posted abroad by their employer to supply a service, with the exception of workers moving for very short duration (for instance business trips) that are not accounted for in the dataset.

For a subsample of six countries (Poland, Romania, Luxembourg, Lithuania, Czech Republic and Hungary), I also collected E101/A1 posting certificates at the origin-destination-sector level. From 2012 to 2017, I can track trade-migration outflows from those countries, in each sector and each destination countries in the EU. This allows me to exploit finer variations in international tax incentives applying to workers posted in different sectors of activities.

I finally collected additionnal country-level data on trade-migration flows in three countries: France, Belgium and Luxembourg. In those three countries, I have access to exhaustive micro registries of foreign workers posted from abroad (France and Belgium) and exhaustive micro registries of all workers sent abroad (Luxembourg). Those additional datatets are extensively described in Muñoz (2021). I use those additional data sources on trade-migration flows for three main purposes in this paper: (i) obtaining additional measures of trade-migration flows at the 5-digit industry level in order to study preferential tax reforms introduced in some sectors (ii) obtaining additional measures of trade-migration flows in order to document intensive margin mobility responses to regulatory duration thresholds (iii) performing robustness checks of the baseline estimates on alternative datasets.

B. Wages, Payroll Taxes and Minimum Wages

I complement the data on international trade-migration flows in Europe with information on payroll taxes, wages and other policy-driven parameters that affect the cost to supply services and to move from one country to the other. Social security contributions and all other payroll taxes are paid in the origin country where their employer is located. Their baseline wage level is also determined in the country of origin, as their contract precedes the posting mission. The relevant cost for the trade-migration decision also includes the posting allowance that firms must pay in some origin and some destination countries. Specifically, for each worker moving abroad, a firm must pay an additional cost determined by the gap between destination-level minimum wage the wage level in the origin country. This additional cost is zero in the absence of minimum wage abroad, or if the destination-level wage is not binding in the origin country.

I measure each components of trade-migration costs for each destination and each origin country using data collected from Eurostat. I use data on employers' labor cost measured ("labour cost index dataset") in a consistent way in each member state from 2009 to 2018 for each European country. Those measures are based on firm-level administrative data and compute the effective labour cost in each member states. The dataset distinguishes employers' cost from wages and from social security contributions, allowing me to measure separately wage and non-wage component of the total cost to send workers from one country to another. To compute the posting allowance that may affect some origin-destination pairs in some years, I also collect data on minimum wages in place in each European country each year. I also collect information on employers' social security contribution rates from the OECD Taxing Wages Dataset.

The final dataset allows me to track yearly bilateral posting service flows within the EU from 2009 to

2017 with measures of countries' wages, payroll taxes and posting allowances. I thus recover standard "gravity" information on bilateral trade-in-services in Europe, overcoming three major measurement challenges usually faced by trade economists. First, unlike for standard exports, social security forms do not have a minimum declaration threshold: I thus have limited missing flows in my dataset.[2] Second, while services' transactions are usually poorly measured due to their intangible nature, payroll tax information on posted workers helps reconstruct reliable administrative records of trade in services. Third, while it is usually very difficult to obtain ad valorem measures of trade costs for services, I can precisely measure the cost to supply services from one country to the other through mobile employees.

2.3 Theoretical Framework

To shed light on the interaction between personal income taxation, international mobility of workers, and trade in services, I start by laying out a simple theoretical framework. While most studies on international migration responses to taxation base their estimations on random utility choice models (Kleven et al. (2014, 2013),Akcigit et al. (2016),Muñoz (2019a)), I use a model of trade-in-services through international mobility of employees, drawing on standard Eaton and Kortum (2002). I make this modelling choice because unlike standard immigration, mobility of posted workers is intermediated by firms' transactions rather than individuals' location choices.

The model considers a world where services are supplied by foreign countries through the geographical mobility of workers. There is a finite number of countries $i \in S$ and a continuum of services Ω_n that every country can produce. Services are produced by combining hours of labor with country i's efficiency in producing services n $z_i(n)$. Unit labor costs in sending countries are wages paid to workers divided by productivity w_i/z_i. To supply services from one country i to another country j, there are mobility costs and frictions m_{ij} that resemble the standard iceberg cost in the trade literature and the mobility cost in the migration literature.

Because of the unique interaction between the country of consumption and production of the service, trade in services through mobile employees requires to choose what taxes and regulations apply to internationally mobile suppliers of services. In Europe, sending firms must pay payroll taxes τ_i in the origin country, based on the origin wage level w_i. Foreign services suppliers may be subject to additional destination-level rules. Prevailing wage and tax policies imply that suppliers located in some countries must top up their sending country's wage level with an additional posting allowance to post workers to country j, which is captured by the general term a_{ij}. In the current posting policy, a posting allowance tops up the sending country's wage level to reach the minimum legal wage of the receiving country. This term is zero if the receiving country does not have a minimum legal wage, if the sending country's wage level is higher than the prevailing wage, or if the service is produced at home.[3] The unit labor cost for services performed by workers posted from i to j is

[2] Silva and Tenreyro (2006) discuss the issue of missing or zero flows in standard trade datasets.

[3] Formally, to post a worker from i to country j where the destination-level minimum legal wage applicable to posted workers is $\bar{w_j}$, the supplier pays $w_i + w_i\tau_i + \mathbb{1}_{w_i<\bar{w_j}}(\bar{w_j} - w_i)$, which I write as $w_i(1 + \tau_i + a_{ij})$.

$$C_{ij}(n) = \frac{w_i}{z_i(n)} \left(1 + \tau_i + a_{ij}\right) (m_{ij}) \tag{2.1}$$

There is perfect competition across service suppliers. Each service is purchased from the country that offers the worker at the lowest unit labor cost, including bilateral mobility cost. This means that a worker is posted from i to j to supply service n iff:

$$C_{ij}(n) \leq min_{i' \in S} \left\{ C_{i'j}(n) \right\} \tag{2.2}$$

Using the assumption of Fréchet distributed productivity such as $F_i(z) = exp\left\{ - \left(T_i z\right)^{-\theta} \right\}$, I can derive for each service n the probability that country i provides the lowest price worker in country j. The density distribution of productivity together with the condition for optimal sourcing choices determines the total number of workers posted from country i to country j. The share of services in country j performed by workers sent from country i is given by:

$$\lambda_{ij} = \frac{T_i \left(c_{ij}\right)^{-\theta}}{\sum_{k \in S} T_i \left(c_{kj}\right)^{-\theta}} = T_i \left(w_i(1 + \tau_i + a_{ij})(m_{ij})\right)^{-\theta} \Phi_j^{-1}, \tag{2.3}$$

where $\Phi_j = \left[\sum_{k \in S} T_i \left(w_k(1 + \tau_k + a_{kj})(m_{kj})\right)^{-\theta} \right]$. Denoting S_j the number of services demanded in country j, the number of workers posted from i performing work in j is given by:

$$S_{ij} = S_j T_i (w_i)^{-\theta} (1 + \tau_i + a_{ij})^{-\theta} \Phi_j^{-1}. \tag{2.4}$$

The model illuminates how tax provisions in trade agreements affect the international mobility of workers intermediated by firms. Exempting trade flows of people from taxes in the destination country- the choice leading to the current trade policy in Europe- leads the international mobility of posted workers to be impacted by the vector of taxes in origin countries. Similarly, clauses that enforce part of domestic regulations on foreign employees mimic the role of a bilateral import tariff. When a high-wage country imposes part of its labor code to a foreign service supplier, export costs rise more for low-standard countries than others. Equation (2.4) summarizes in a straightforward manner why personal taxes matter for trade in services and international migration jointly. In this baseline framework, we can immediately state that the number of workers flowing from country i to country j is decreasing in the origin-level tax rate τ_i and in the destination-level prevailing cost a_{ij}, and increasing in the destination-level tax rate τ_j.

2.4 Reduced-Form Estimates of the Trade-Migration Elasticity

I start the analysis by showing reduced-form graphical evidence of the impact of taxation on international migration and trade in services. First, I study cross-country correlations between tax differentials and location. This provides suggestive evidence that taxes matter for trade-in-services and international mobility of employees in the long-run. Second, I consider country-specific tax and regulation reforms that create compelling identifying variation and provide conclusive evidence of the relationship between taxes and trade-migration flows in the medium-run.

2.4.1 Steady-State Correlation Between International Trade-Migration Flows and Taxes

To shed light on international trade-mobility responses to labor taxes, I start by documenting the empirical relationship between posting flows and labor cost at the aggregate level. The "origin-based" tax treatment of posted workers generates origin-specific labor cost variations within a receiving country: workers posted from low-tax countries are cheaper to hire than domestic workers at the same workplace. I show in the top panel of Figure 2.1 the relationship between levels of bilateral posting flows and differentials of labor taxes between receiving and sending countries. Payroll cost ratio can be substantial and reflects the heterogeneity in terms of payroll taxes within the EU. Non-wage hourly labor cost is 8 times higher in France, Germany and Austria than in Poland, Bulgaria or Romania. Country pairs characterized by a large gap between receiving and sending labor cost are also the one that experience the largest posting flows.[4] By constrast, posting flows from high to low labor cost countries are of marginal size. To generalize this cross-country relationship, I show in the bottom panel of Figure 2.1 the binned scatter plot of (log) posted workers flows and (log) destination-origin payroll tax differential for all country pairs over 2009-2017. I depict the best linear fit using a univariate regression. Figure 2.1 shows that a tight aggregate relationship holds between posting flows and labor cost differentials: workers tend to be posted from low to high labor cost countries, with a cross-sectional correlation between (log) posting flows and (log) destination-origin payroll cost ratios of 0.52(.04) significant at the one percent level. Figure B.1, Panel B shows an equally large trade-migration flows elasticity when weighting postings by wages, while Figure **??** shows equally large cross-country correlations using (log) payroll tax rates or (log) total cost ratio as alternative measures of cost differentials.

If the cross-sectional relationship is informative of the steady-state impact of payroll taxes on posting flows, many factors could be simultaneously correlated with employers' labor costs and the magnitude of mobility-dependent trade. To properly estimate the causal effect of labor cost policies on posting flows, it is crucial to exploit exogenous variations in labor costs while controlling for these simultaneous factors. Next, I consider quasi-experimental variation created by tax reforms, which allows me to fully control for these identification threats and provide conclusive evidence of a link between taxation and trade-migration flows.

2.4.2 Country-Case Studies: Tax Reforms

This section illustrates international migration and trade responses to large and exogenous reforms in employers' payroll taxes. The source of variation comes from the origin-based tax treatment of posting flows in Europe. I study two quasi-natural experiments: (i) a large reform in employers' social security contributions in one of the largest sending countries (Slovenia), (ii) a large reform in employers' social security contributions in one of the largest receiving countries (Belgium). For each country specific tax reform case study,

[4] Net sending countries are mostly established in Eastern and Southern European countries that are characterized by much lower levels of wages and social contributions (Figure **??**). While Eastern Europe represents only 20% of the active European population, it represents almost 50% of international mobile services provision (Figure A.56), while more than 85% of posting missions are performed in the territory of EU-15 countries.

table 2.1 presents elasticity estimates using a difference-in-differences comparison of the treatment country and the control country before and after the reform. Those elasticities are obtained from a 2SLS regression of the form log S_{it} = $e \log w_i(1+\tau_{it}+a_{ij})$ + $1(i=T)$ + $1(t \geq t_0) + \varepsilon_{it}$, instrumented with $1(i=T) \times 1(t \geq t_0)$, where i is (origin or receiving) country (the treatment country T or the control), t is the year, t0 is the year of the tax reform. Those estimates capture medium-term responses as I compare outcomes a few years before the reform to a few years after the reform. The estimated coefficients can be interpreted as reduced-form elasticites rather than structural parameters accounting for all model-based determinants.

A. The Slovenian Posted Bonus

I first study the implementation of a reform in Slovenia that decreased the labor cost for workers posted by companies located in Slovenia. The reform was implemented in end of 2012 by a new social security regulation (*ZPIZ-2 par 144*). It establishes that payroll taxes paid by Slovenian firms on posted workers' wages are capped to 60% of the average annual salary in Slovenia after the reform, introducing a large labor cost cut for workers posted by Slovenian suppliers.[5] The reform introduces a sharp decrease in the social security contribution rate paid by Slovenian employers, of about 40% for workers paid at the average wage level (Figure B.6). According to the theoretical framework, this payroll tax cut should increase trade-migration flows from Slovenia ($dS_{ijt}/d\tau_{it}$<0).

To estimate the effect of this origin-specific tax cut on posting flows, my empirical strategy is a difference-in-differences where I compare the flows of workers posted from Slovenia affected by the payroll tax cut after 2012 with workers posted from similar countries not affected by the tax cut, within the same receiving country. My control group contains workers posted from other new member states (NMS) of 2004: these countries face the same posting restrictions as Slovenia in all receiving EU countries and are similar in many aspects (geography, development path, industrial specialization). Given that posting flows from Slovenia and other NMS of 2004 are affected by similar shocks, they should have followed similar trends absent the reform's implementation in Slovenia.

Figure 2.2 shows graphically the differences-in-difference setting provided by the reform. The top panel plots the number of posted workers from 2008 to 2017 (normalized to one in 2012 just before the reform implementation) sent by Slovenia (treatment) and by other NMS (control) to Austria, the main receiving country for workers posted from Slovenia. Focusing on the differential evolution of treated versus control flows to the same receiving country allows me to graphically differentiate out the destination-specific term Φ_{jt} that should affect demand for workers posted from Slovenia and other NMS 2004 countries similarly. The figure shows compelling evidence that the number of workers posted from Slovenia increased after the payroll tax cut compared to workers posted from other comparable countries. While the series were following parallel trends before the reform, the number of workers posted from Slovenia to Austria increased threefold five years after the tax cut. Over the same period, posting flows from control countries stayed very

[5]The effect of this payroll tax cut "posted bonus" has been documented by a worker union (EFBHWW) that filed an official complaint at the European court of Justice in 2019. The complaint against Slovenia argues that this payroll tax cut for workers posted from Slovenia lowers labor cost for Slovenian suppliers and creates unfair competition between European countries.

stable, suggesting the observed increase in Slovenian postings has been primarily driven by the reform. The reduced-form elasticity of posted worker flows with respect to the origin-based payroll tax rate given by this country-level experiment is large and significant, with a point estimate of -2.3 (0.35) in Austria, -2.2 (0.35) in Germany, and -1.62 (0.24) for all receiving countries, controlling for destination-year fixed effects.[6] Next, Figure B.8, Panel A, repeats the difference-in-differences setting using the synthetic control method a la Abadie et al. (2010a) to build an alternative control country, matching on pre-reform trade-migration flows .The figure compares all workers sent from Slovenia to all destination countries, to the number of workers posted from the synthetic country to all destination countries. The results are extremely similar, with an implied reduced form trade-migration elasticity with respect to payroll tax rate in the origin country of -2.3(.71).

B. The Belgian Tax Shift

I then study a large exogenous payroll tax cut reform in one of the main receiving countries, Belgium. At the end of 2015, the Belgian government announced a large decrease in labor taxes ("tax shift"): employers' social security contributions rate on all employees hired in Belgium was decreased from 33% to 25% starting at the beginning of 2016.[7] The payroll tax cut was implemented by the Belgian government as a means of decreasing the budget deficit and applied to the entire Belgian labor market. The tax change was not introduced in response to posting-specific trends, alleviating worries that the tax cut would affect the number of foreign workers in Belgium through other channels than the policy change itself. According to the theoretical framework, this payroll tax cut should decreases trade-migration flows to Belgium ($dS_{ijt}/d\tau_{jt}$>0).

To empirically investigate the effects of this destination-specific payroll tax cut on posting inflows, I rely on a difference-in-differences setting where I compare the flows of workers posted to Belgium before and after the reform to the flows of workers posted to a similar receiving country not affected by the tax shift. I use workers posted to France as my control group because of common characteristics between these two countries: they share a border and a language, are among the largest receiving countries, and have a similar origin and sectoral composition of posting inflows. Postings to France and Belgium should be affected by similar regional and origin-specific shocks, while only posting flows to Belgium should be affected by the reform. Specifically, focusing on a receiving country with a similar composition of posting inflows allows me to filter out the importer-specific effect while exploiting a shock in the destination-specific term Φ_{jt}. Investigating the pre-reform trade-migration flows to the treated and control group will allow me to gauge the plausibility of my identifying assumption: the control country provides a credible counterfactual for the number of workers sent to Belgium absent the nation-wide change in payroll tax contributions. Figure B.5 shows the evolution of employers' social security contribution marginal rates in Belgium and France, before and after the implementation of the "tax shift" reform. Payroll tax contributions decreased

[6]The corresponding reduced form estimates for the elasticity of trade-migration flows with respect to origin-specific non-wage labor cost component are respectively -1.77 (.23), -1.70(.24) and -1.3(.18), while the elasticity with respect to total wage cost is larger, with a point estimate of -5.5(.72).

[7]The decrease in employers' social security labor cost was progressively implemented, and the rate of contributions was decreased from 33% to 30% in 2016, then from 30% to 28% in 2017 and from 28% to 25% in 2018.

dramatically in Belgium after 2015, with a roughly 30% decrease in the employers' tax rate between 2015 and 2019. During the same period, the average social security contribution rates paid by employers in the neighbouring control country remained stable until 2018.

Figure 2.2 shows graphically the differences-in-difference setting provided by the reform using administrative posting registries in France and Belgium. The bottom panel plots the number of posted workers from 2010 to 2018 (normalized to one in 2015 just before the reform implementation) sent to Belgium (treatment) and to neighboring France (control). The identifying assumption is that postings to France and Belgium should be exposed to similar shocks and should follow similar trends in the absence of the reform that distorts the cost of services supplied in Belgium only. Posted worker flows to these two receiving countries were following perfectly parallel trends before 2015, suggesting that posting to France provides a credible comparable counterfactual for postings to Belgium. Postings to Belgium started to slow down immediately after the tax shift was implemented, while the number of workers posted to France kept growing at a fast rate. In line with the previous experiment, the bottom panel of Figure 2.2 provides compelling evidence that the large decrease in employers' labor cost implemented in Belgium significantly slowed down posting flows to this country compared to a comparable neighboring receiving country. The implied estimated reduced-form elasticity of trade-migration flows with respect to destination-specific payroll tax rates is 3.1(1.1). I then test the robustness of the estimated trade-migration responses to the large change in payroll tax rates. To provide an out-of-sample test of the robustness of the reduced-form elasticity estimates, Figure B.7 repeats the analysis using an alternative dataset of posting flows, the EU-A1 dataset. The trade-migration elasticity estimated for the same tax variation but different data is 1.5(.71) and is not statistically different from the previous estimates, although standard errors are larger. Next, Figure B.9 repeats the difference-in-differences setting using the synthetic control method a la Abadie et al. (2010a) to build an alternative control group, matching on pre-reform trade-migration flows (Panel B). The estimated reduced form trade-migration elasticity with respect to the payroll tax rate in the receiving country using the synthetic control method is again very similar, with a point estimate of 2.06.

Overall, the graphical evidence in this section shows that consistent with the model, trade-migration flows are a decreasing function of payroll tax rates in the origin country and an increasing function of payroll tax rates in the destination country.

2.4.3 Country-Case Studies: Preferential Schemes for Posted Workers

I have shown that two large employer labor cost reforms have significantly affected posting flows in Slovenia and Belgium, with estimated reduced-form elasticities with respect to payroll taxes way above one, already suggesting that destination-level labor cost policies, such as payroll tax exemptions, shape mobility-dependent trade flows. While the difference-in-differences settings created by those reforms offer compelling evidence of significant migration responses to taxes, one remaining confounder lies in destination or origin-specific shocks that are simultaneous to the tax variations. For instance, a reform in Belgian payroll taxes could be correlated with other policy changes that would affect incoming postings absent the tax change. Without an additional control group or variation, this setting does not enable to control for such destination-year fixed effects that are fully collinear with the identifying tax variation.

To tackle this issue, I next exploit the introduction of preferential schemes that create sharp changes in the incentives to post workers within a given receiving and sending countries. I study three quasi-natural experiments: (i) the repeal of payroll tax exemptions for temporary employment agency workers posted from Luxembourg (ii) the repeal of payroll tax exemptions granted to trade-migration flows after a certain duration threshold and (iii) the introduction of a posting allowance for foreign workers sent from low-wage countries to the German manufacturing sector. Because those preferential schemes generate variations in cost within-country, I can estimate the reduced-form elasticity of trade-migration flows controlling for all time-varying shocks in the country where the tax reform occurs.

A. Effect of the 2010 Tax Arbitrage Regulation

I start by studying a change in the European regulation on social security coordination (EC Regulation 883/2004) that entried into force as from 1 May 2010. The reform of 2010 aimed at reinforcing the rules related to social security exemptions for posted workers in contexts that could be interpreted as tax avoidance. The novel regulation was discussed and adopted at the European-level, and the implementation date was decided by the European Commission.

It first establishes that workers that have not been affiliated to the SSC organization of the origin country for at least a month cannot be exempted from destination labor taxes if they are posted abroad. Second, the reform reinforces the condition under which payroll tax exemptions can be granted to individuals who are posted to their own country of residence. After 2010, a French resident posted to France by a company established in another country has to pay the French social security contributions. Finally, the reform implements clearer limitations under which the companies can post workers abroad while staying affiliated to the origin country social insurance system. Sending firms must perform more than a pure administrative activity in the sending country ("*substantial activity rule*") in order to benefit from payroll tax exemptions in the destination country.

The new European regulation was primarily targeted at trade-migration flows intermediated by temporary employment agencies, compared to other type of postings. As temporary employment agencies specialize in hiring and providing labor to (domestic and foreign) using firms, hiring of workers from abroad in order to post them immediately to a third country is more likely to occur in this sector. Temporary employment agencies were also much more specialized in "artificial postings" that is to say the posting of resident to their own country of residence through a company located elsewhere: before 2010, the vast majority of French workers posted to France were hired by a foreign temporary employment agency based in Luxembourg. I study how the reform impacted trade-migration incentives in treated sectors and treated countries. I take advantage of unique administrative matched employer-employee data for all firms located in Luxembourg merged with information on all postings from Luxembourg since 2004. Luxembourg is an ideal laboratory to study the effects of this regulatory change, as it is the country where (i) "artificial" postings were the most substantial and (ii) postings from temporary employment agencies is large. The data shows that more than 70% of workers posted from temporary employment agencies in Luxembourg were French residents. Linking the reform to the framework developed in the past section, exposed temporary employment agencies located in Luxembourg face a payroll tax rate of τ_j instead of τ_i after 2010.[8] The sharp variation in payroll tax rates faced by temporary employment agencies is exemplified in Figure B.4: taxes on posted workers sent from Luxembourg in the treated sector more than doubled after the reform, increasing from 15 to 44 percent. For other sectors, as well as for domestic employment in the same sector, payroll tax rates remained unchanged after the implementation of the novel regulation.

Figure 2.3 shows graphically the differences-in-difference setting provided by the reform. The top panel plots the monthly number of workers hired by temporary employment agencies in Luxembourg from 2004 to 2020 (normalized to one in march 2010 just before the reform implementation) posted abroad (treatment) and working domestically (control). The identifying assumption is that services performed at home or abroad should be exposed to similar shocks and should follow similar trends in the absence of the reform that distorts the cost of services supplied abroad only. The two series followed parallel trends in months preceding the reform, suggesting the the employment of temporary agency workers in Luxembourg provides a credible counterfactual for the evolution of temporary agency workers sent abroad by Luxembourgish firms. The series started to diverge immediately after the 2010 reform. The month after that tax arbitrage is limited by the Directive, the number of workers posted from Luxembourg decreases by 40% compared to the pre-reform level. In comparison, the number of workers hired in the same sector but performing work domestically, and therefore not affected by the change in payroll taxes, increased during the same period.[9] The reduced-form elasticity of posted worker flows with respect to the change in payroll taxe rates induced by the reform is large and significant, with a point estimate of -1.3(.13).[10] Thanks to the sector-specific nature of the variation, the inclusion of year fixed-effects when estimating the elasticity filter-out exporter-year fixed effect, thus controlling for all potential general equilibrium effects in the origin country. The reduced-form estimate is smaller than the one obtained before, suggesting that general equilibrium effects at the origin-year level may bias the reduced-form estimates upwards.

Figure 2.3, Panel A evidences that the end of payroll tax exemptions induced an immediate collapse in posting of workers abroad in comparison with domestic supply of services not treated by tax exemption rules. The difference-in-differences setting allows to rule-out sectoral shocks that would occur the same month of the payroll tax reform and would affect similarly the supply of temporary employment services at home and abroad. Despite the absence of differential trends before the reform, the decrease in posting flows could be caused by a simultaneous unobserved shock affecting all posting flows, beside the effects of the labor tax exemption reform. To test this assumption, I move to a triple differences design, looking at the differential evolution of posting and domestic flows in sectors less affected by the reform, such as transport and construction. If the results are confounded by a differential change in non-reform related

[8] In that case, $a_{ij} = 0$ because the minimum wage in Luxembourg is higher than the minimum wage in France.

[9] The model shows that an increase in the cost of posting workers from i to j affects directly postings from i to j S_{ij}. A change in posting cost between i and j can also indirectly affects postings between other country pairs, including S_{jj}, through the multilateral resistance term Φ_j. In a small countries setting, those indirect effects are likely to be small and the first-order effect of the reform can be approximated by the direct change in S_{ij} only.

[10] Running the same regression using $\log(w_{it}\tau_{ijt})$ as a regressor yields an estimated elasticity of -1.9(.18), while the reduced form elasticity using $\log(1+\tau_{ijt})$ as a regressor is -6.2(.33).

trends, this would show up in the migration patterns of workers less affected by the 2010 reform. Figure 2.3, Panel C plots the yearly number of workers hired in the transport sector in Luxembourg from 2004 to 2020 (normalized to one in 2010 just before the reform implementation) posted abroad (treatment) and working domestically (control). In this sector where posting is also really prevalent, but that was not targeted by the tax exemption reform, trade-migration flows did not decline compared to domestic employment after 2010. The implied (placebo) trade-migration elasticity in the sector not affected by the change in payroll tax exemption is close to zero, and is statistically different from the elasticity estimates in the treated sector. Using the placebo sector allows me to relax the parallel trends assumption required for identification in Figure 2.3, Panel B, by controlling for potential differences in pre-trends. Specifically, I can compare flows of workers posted from Luxembourg versus employed domestically in the temporary employment sector versus the transport sector, before and after that payroll taxes change for posted workers in temporary employment agencies. I can now estimate the reduced-form elasticity adding sector-year and destination-year fixed effects.[11] Once again, the migration-trade elasticity is large and statistically significant at the one percent level, with a point estimate of -1.37(.08).

B. Effect of the Payroll Tax Exemption Threshold

To provide additional evidence on the relationship between international mobility of suppliers of services and tax differentials, I next study posting responses to payroll tax exemption duration thresholds. Specifically, the European regulation establishes a maximum mission duration for tax exemptions granted to posted workers. If firms send workers abroad for a contract lasting longer than the regulatory threshold, social security contributions are due in the destination rather than the origin country. Those discontinuities in payroll taxes around contracts' duration change trade-migration incentives at the *intensive* margin. In the presence of substantial international mobility responses to payroll taxes, as showed in Figure 2.3 for the extensive margin, we expect a distorted distribution of posting duration around the tax exemption threshold. If firms avoid paying taxes in the destination country, there should be an excess mass of posting missions just below the tax exemption threshold, following the intuition from the bunching literature (Kleven (2016)).

From 2010 to 2018, posted workers could be exempted from destination-level taxes and rules if they were posted for less than 24 months in that country. Since 2018, a new directive reduced this threshold to 12 months with a guaranteed extension to 18 months if the foreign firm submits a motivated notification. The directive was transposed in the French labor law in 2019, and entried into force in July 2020. The European setting thus creates an exogenous change in the tax incentives discontinuity created by tax exemption thresholds. This allows me to use the pre-reform empirical distribution of posting missions as a credible counterfactual for the distribution of postings absent any discontinuity in payroll taxes for missions just below and above the newly implemented regulatory threshold.

I use exhaustive micro data on all workers posted to France from 2017 to 2021 to illustrate the effects of the discontinuities in tax differentials created by the law. The dataset allows me to observe for each posting

[11] Formally I estimate the regression $\log S_{ijst} = e\log(\tau_{sijt}) + 1(j = T) + 1(t \geq t_0) + 1(s = T) + \gamma_{st} + \gamma_{jt} + \varepsilon_{jts}$, instrumenting payroll taxes with $1.(j = T) \times 1.(t \geq t_0) \times 1.(s = T)$.

mission, posted worker and sending country the duration of the work performed in France each year. Figure 2.4 plots the distribution of posting contracts of all workers sent by foreign firms to France by year of posting mission start. The distribution of posting contracts exhibits a short spike just below 2 years duration in 2017, which corresponds to the tax exemption threshold for that year. This is first evidence that trade-migration flows react to payroll tax exemption incentives through changes in the duration of the contracts performed abroad. Those distortions in the distribution of posting duration could however come from other discontinuities around the 2 years threshold that affect trade-migration incentives beside tax exemptions. For instance, firms may just find it convenient to declare a 2 year posting mission due to the salience of "round numbers". The 2020 reforms allows us to verify that bunching at the 2 years threshold observed in 2017 in Figure 2.4 (blue line) is driven by tax incentives rather than other factors. The red line in Figure 2.4 plots the distribution of posting contracts starting in 2020, after that the tax exemption threshold has been moved from 2 years to 18 months. In 2020, a substantial bunching jn the distribution of the posting contracts appears at the new tax threshold, while the excess mass at the old exemption threshold becomes substantially lower. This confirms that the prime driver of posting duration responses to the exemption threshold is the tax incentives rather than other simultaneous discontinuities. Overall, the graphical evidence presented in this section shows that removing payroll tax exemptions granted to posted workers significantly reduce trade-migration flows, both at the extensive (migration flows) and intensive (duration of contracts) margins.

C. Country-Case Studies: Minimum Wage Reforms

I now study a quasi-experimental change in the posting allowance a_{ij} that allows me to control simultaneously for origin-year and destination-year fixed effects, in order to differentiate-out demand and supply shifters that could affect cross-border service flows. Specifically, I study the effects of minimum legal wage implementation in Germany, where no national minimum statutory wage was in place until 2015: minimum pay rates were agreed upon at the sectoral or firm level and were therefore not applicable to posted workers.[12] Since 1996, only construction-related industries are entitled to a minimum legal wage regulation at the sectoral level.[13] In August 2014, the meat processing industry implemented a minimum legal wage in the sector, before that a national minimum wage was implemented in January 2015 in all sectors. In a nutshell, foreign firms sending workers to Germany in the construction sector must always pay the posting allowance (a_{ij}) due to the sectoral minimum wage. For firms sending workers to Germany in other industries than construction, the reform increases their cost from $w_i(1+\tau_i)$ to $w_i(1+\tau_i+a_{ij})$ if their origin-level wage is below the new minimum wage ($w_i < \bar{w_j}$).

To study the compelling variations cretated by this policy change, I use data on bilateral *sectoral* posting flows that are available for a subset of sending countries: Poland, Luxembourg, Hungary, Czech Republic,

[12] Foreign services suppliers are only bound to comply with destination-level minimum legal wages, or generally applicable rules. Therefore, most industry-level or firm-level minimum pay rules do not apply to posted workers.

[13] In 1996, the prevailing wage policy for posted workers was implemented in Europe and adopted by German national law through the "Posted Workers Act" (AEntG law). Remarkably, this law created the first legal basis for minimum sectoral legal wage in Germany. Since 1996, sectoral minimum legal wages in Germany have been thus implemented through the addition of branches in the AEntG scope. This anecdote shows that not only do prevailing wage policies play the role of trade policies for on-site offshoring, but they also triggered the implementation of sectoral minimum wage for domestic workers as a way to protect domestic labor markets from foreign competition.

Lithuania, and Romania. I observe workers sent by firms located in those countries in both manufacturing and construction sectors, in all destination countries, since 2012. Panel A of Figure 2.5 shows the difference-in-differences setting provided by the reform. It plots the yearly number of workers posted to Germany (normalized to one in 2013 the year before the reform) in the construction sector (blue line, control) and manufacturing industries (red line, treated), before and after the prevailing cost variation depicted by the vertical red line. The identifying assumption is that postings in construction and manufacturing should be exposed to similar yearly shocks and should follow similar trends in the absence of the reform that distorts the cost of posting in the construction sector only. The figure shows that postings to Germany in construction and manufacturing were similar in 2012, but the two series started to diverge in 2014 when the prevailing minimum wage was implemented in the meat industry. Postings to the German manufacturing industries decreased further in 2015 when all manufacturing industries became regulated by a minimum wage for posted workers, while postings in construction stayed close to their pre-reform level. The corresponding estimates indicate that postings differentially decreased by 60% in sectors treated by the reform, accounting for origin-year and destination-year fixed effects. The reduced-form elasticity with respect to the posting cost is -1.57(.57), again very close to our past estimates.

To confirm that this finding is not driven by origin-specific sectoral supply shocks simultaneous to the minimum wage reform, I next use a triple differences approach and compare the evolution of postings in treated and untreated sectors in countries treated and untreated by the minimum wage reform. Graphically, I use France as a control group because Germany and France are neighboring countries and the two largest users of posting services. Here, the identifying assumption is that the relative postings in construction versus manufacturing should be exposed to similar yearly shocks in France and Germany absent the reform that distorts the cost of posting in Germany only. The bottom panel of Figure 2.5 shows that the gap between manufacturing and construction postings stayed stable in the control country (France), while it decreased sharply immediately after the minimum wage reform in 2014 in Germany. This confirms that the decrease in manufacturing versus construction postings to Germany is not driven by origin sectoral shocks that would have affected France and Germany similarly. Formally, the regression model is:

$$\log S_{ijts} = \gamma_{ijt} + \gamma_t + \gamma_{st} + \beta \times 1.[t \geq t_0] \times 1.[j = T_j] \times 1.[s = T_s] + \varepsilon_{ijt} \tag{2.5}$$

Where γ_{ijt} controls for origin-destination-year fixed effects and γ_{st} controls for sector-year shocks. With the set of fixed effects allowed by the origin-destination-sector cost variations created by the reform, β captures the differential migration responses to posting cost within a given country-pair and sector, accounting for all shocks that affect postings between two countries each year. The estimates of the triple differences model accounting for pair-year and sector-year fixed effects indicates that postings to Germany in the treated sector differentially decreased by 57% after the reform.

The double and triple differences models rest on the assumption that the construction sector provides a credible control group for postings in manufacturing. These sectors could, however, be affected by unobserved shocks within a given receiving or sending country. A particular concern is that the implementation of the minimum wage in the German manufacturing sector affects the demand of posted workers in that sector through other channels than the change in labor cost for posted workers. To make progress on this issue, I take advantage of exogenous variations *within* the treated industry across sending countries. The identifying variation comes from the *kinked* relationship between the cost shock caused by the minimum wage reform and the pre-reform wage level in sending countries, illustrated in Panel C of Figure 2.5. The simple intuition is that the destination-sectoral cost reform implemented in Germany in 2014 makes trade-migration more costly in countries where the new minimum wage is binding, compared to other sending countries. In that sense, the reform mimic the effect of a bilateral trade tariff that penalizes more imports of services from some countries. Firms located in low-wage countries such as Romania or Hungary need to pay a large additional allowance after 2014, while the wage cost of workers posted from high-wage countries such as Luxembourg are not directly affected by the new German regulation. My identification strategy thus compares how *within* the treated sector (manufacturing) posting flows from exposed versus non-exposed countries evolved differentially in Germany versus other countries, before and after the reform, controlling for pair, origin-year and destination-year fixed effects. Formally, the migration elasticity can be estimated from the 2SLS model:

$$\log S_{ijt} = \gamma_{it} + \gamma_{jt} + \gamma_{ij} + e \log w_{it}(1 + \tau_{it} + a_{ijt}) + \varepsilon_{ijt} \tag{2.6}$$

instrumented with $1.[t \geq t_0] \times 1.[j = T_j] \times 1.[i = T_i]$, where S_{ijt} is the number of workers sent from country i to country j at time t in the treated sector, γ_{it} is a origin-year fixed effect and γ_{jt} is the destination fixed-effect, T_i are origin countries for which the new minimum wage is binding, T_j is Germany and t_0 is the year of the reform. My set of fixed-effects filters-out all changes in the German labor market correlated or caused by the implementation of the minimum wage, only exploiting origin-specific variations in exposure to the nation-wide change in labor cost. With this set of fixed-effects, the coefficient estimates on the trade-migration cost identifies the structural parameter θ. The migration elasticity with respect to cost is large and statistically significant with a point estimate of -1.27(.59), once again very close to the estimates obtained using different variations and different datasets, and smaller than the reduced-form estimates that do not account for general equilibrium effects.

To further exemplify the heterogeneity in trade-migration responses to cost variations by exposure to the reform, I re-estimate Equation (2.6) interacting the treatment interaction $1.[t \geq t_0] \times 1.[j = T_j]$ with a sending-country fixed effect and plotting estimates for each origin country. Figure 2.5, Panel D plots for each sending country the estimates of the trade-migration responses to the German reform (y-axis) by pre-reform distance to the new minimum wage implemented in 2014-2015 (x-axis). The figure shows that countries experiencing the largest cost shock exhibit the largest trade-migration responses the shock. The treatment effect in origin countries where the new German minimum wage is not binding and plotted in light blue in the Figure, is zero. This heterogeneity analysis proves that exogenous changes in trade-migration incentives following the reform are the prime driver of the estimated elasticity. In Figure B.10, I finally repeat the exercise for the untreated construction sector, acting as a placebo test, and shows non-significant trade-migration responses to the reform in the sector that should not be directly affected by it. The placebo trade-migraiton response is not statistically different from zero.

2.5 Theory-Consistent Estimates of the Migration-Trade Elasticity

This section presents results based on a theory-consistent estimation of the gravity model, exploiting simultaneously all sources of variation in wages, payroll taxes and prevailing cost policies in all 26 member states over the period 2009-2017. I focus on the 2009-2017 period where most of posting flows are liberalized and where I can compute the bilateral cost to post workers from one country to another, using Eurostat data on payroll tax rates, minimum wages and average wages in each European country. I take my model to the data, estimating the equilibrium value of bilateral trade-migration flows determined by Equation (2.4), using as a dependent variable S_{ijt} the number of postings from country i to j at time t and controlling for all structural determinants of supply and demand of services' flows

$$S_{ijt} = \exp\left\{-\theta \log\left(w_{it}\left(1+\tau_{it}+a_{ijt}\right)\right) - \theta \log(m_{ijt}) - \log\left(\Phi_{jt}S_{jt}\right) + \theta \ln T_i\right\}. \tag{2.7}$$

where w_{it} is the wage paid in country i and year t, τ_{it} is the payroll tax rate faced by employers located in country i and year t , a_{ijt} is the posting allowance that a firm must pay to send workers from i to j in year t determined by the minimum legal wage in j (if any), m_{ijt} are bilateral migration costs that can vary over time due to changes in regulations, $\Phi_{jt}S_{jt}$ captures the multilateral resistance term e.g accessibility of country j for trade-migration fom all origin countries. The main challenge in estimating the trade-migration elasticity θ is to exploit exogenous variations in costs, accounting for simultaneous shocks that affect demand and supply of cross-border services and international migration within a given country pair. As in the reduced-form analysis, I use payroll tax and minimum wage reforms in place of standard "trade tariffs" to identify the posting elasticity. I follow the best-practice methods for theory-consistent structural gravity estimations that are summarized in Head and Mayer (2014). Importantly, I estimate Equation (2.7) at the national level (one observation by destination-origin-year), and the measures of payroll taxes τ_{it} and posting allowances a_{ijt} from country-level data are not adjusted for the sector×year or origin×year preferential schemes exploited in the country-specific case studies. For instance, the end of payroll tax exemptions that only applies to temporary employment agencies for Luxembourg after 2010 is not captured. Similarly, the Slovenian posted bonus only applies to Slovenian firms posting workers abroad and is therefore not reflected in Eurostat data on the payroll tax rates in Slovenia. This has two implications for interpreting the theory-based estimates of θ. First, due to measurement error, the trade-migration elasticities from Equation (2.7) will be biased towards zero. We therefore expect the estimates of θ to be lower than the reduced-form estimates presented in Table 2.1. Second, the gravity estimation acts as an "out of sample" test for the country case-studies. While exploiting different variations, and different measures of bilateral posting flows, the structural estimation should yield a consistent estimates of θ that would enable us to predict the variations triggered by the sector-year or origin-sector-year specific cost variations studied in Table 2.1.

I present my estimates in Table 2.2. The top panel uses variations in payroll taxes alone while the middle panel exploits all variations in total wage cost of posted workers. All specifications include destination-origin fixed effects (filtering-out bilateral migration costs m_{ij}) and a free posting agreement dummy (filtering-out m_{ijt}) to account for variations in posting regulations over time. As demonstrated by Anderson and Van Wincoop (2003), failure to account for the multilateral resistance terms can lead to severe biases in the estimates of the gravity coefficients. Therefore, all specifications include destination-year fixed effects (filtering-out $\Phi_{jt} S_{jt}$) that account for a country "remoteness" in terms of trade-migration. I cluster standard errors at the destination-year level to account for potential autocorrelation of error terms within a given destination country and time period. The structural parameter θ is primarily identified by *origin-specific* payroll tax variations *within* receiving countries (workers posted from different countries pay different taxes in the same receiving country) as well as *origin-destination* minimum wage variations (workers posted from different countries are affected differentially by destination-level changes in minimum wage). Those variations mimic the country-specific case studies studied in details in the previous section, with estimates reported in Table 2.1.

Column (1) presents the basic specification with pair fixed-effects and destination-year fixed effects, and therefore exploits variation *within* country and year in the payroll taxes on different posted workers. This strategy is exemplified by figure 2.2 Panel A (decrease in payroll taxes for Slovenian posted workers) and figure 2.2 The control for unobserved time-varying destination characteristics enable to filter-out all destination-specific shocks that would be correlated with changes in labor cost in a given origin country. Furthermore, this specification also controls for potential general equilibrium effects of trade-migration flows on the overall demand for workers in country j. As in standard trade models, my theoretical framework features a world where producers choose among and consume services supplied by domestic and foreign suppliers. To be fully consistent with theory, Equation (2.7) should therefore also reflect the differential use of domestic versus posted services. Column (1) thus also includes services supplied domestically (S_{jjt}) in the sample of estimation.[14] The coefficient on payroll taxes is large and strongly significant at -.71(.20). The estimated elasticity is slightly larger when using total wage cost as a regressor, with -θ=-.78(.23). These estimates are a bit larger than the steady-state correlation presented in Figure 2.1 but lower than reduced-form estimates presented in Table 2.1. This is intuitive, because the model-based estimation leveraging all tax variations at the country-level may be affected by measurement error, due to the omission of sector-specific or posting-specific variations. It is worth emphasizing that the Rsquared of the gravity model is large (.96), and very close to what the literature finds when estimating more standard gravity, using bilateral data on trade in goods or trade in services. This suggests that the simple trade model performs well in explaining the geography of cross-border supply of services.

Column (2) repeats Column (1) specification removing internal flows from the estimation sample. The estimates remain stable with a coefficient of -.75(.21) for payroll taxes and of -.82(.24) for total wage cost.

[14] To measure S_{jjt}, the yearly number of domestic workers performing work for domestic producers established in j, I use total domestic employment in country j at time t minus the total number of workers posted from j at time t to work for other EU countries. This methodology is the counterpart for mobile services supply of the standard approach in the literature that uses domestic production minus total exports.

The estimates of the trade-migration elasticity do not seem to be driven by the inclusion or not of flows of workers that supply services locally.

Column (3) repeats my baseline specification of Column (1) now using a Poisson pseudo-maximum likelihood (PPML) estimator instead of OLS. It has been well documented that the log-linearization of the multiplicative gravity equation can be biased by zero flows and heteroskedastic error terms (Silva and Tenreyro (2006)).[15] Estimates with log-linear OLS and PPML are ressuringly close. This is unsurprising, as the amount of zero flows in the trade-migration flows dataset is small due to the absence of declaration threshold for cross-border supply of services, in contrats with standard custom data. The estimated coefficient on payroll taxes is -.66(21) and 1.2(.15) for total wage cost.

Column (4)-(6) repeats the three past specifications weighted by the sending country's population to adjust for countries' size heterogeneities. The point estimates are slightly larger when using weights but lie in the same ballpark as estimates from unweighted regressions. The coefficients estimates range from -.97(.27) to -1.4(.27) and are now closer to the reduced-form estimates using country-specific tax reforms.

Next, I repeat the estimation with a Poisson regression using trade-migration shares λ_{ijt} as the dependent variable, as suggested by Eaton, Kortum, and Sotelo (2012). The intuition is that estimating structural gravity using shares rather than levels (while including destination fixed effects) avoids biasing the structural parameters estimates towards large countries. This estimator is also the one validated by Monte-Carlo simulations, as demonstrated in Head and Mayer (2014). Estimated elasticities displayed in Columns (7) are now larger, with point estimates above one. The implied trade-migration elasticity ranges from -1.1(.38) to -2.4(.47) and is now extremely close to the reduced-form estimates of international mobility responses to country-specific tax reforms presented in Table 2.1.

So far, the identification has used exogenous variations in payroll taxes affecting differentially workers sent to the same destination country, controlling for all changes in demand and supply of labor in the receiving country. One potential remaining confounding factor lies in unoberserved shocks occuring the same year than a tax reform and affecting the supply of posted workers through other channels that the trade-migration cost itself. For instance, a payroll tax cut may be implemented jointly with other policies that boost companies' productivity and make them more competitive to supply services, leading the estimates to be biased upwards. Such confounding shocks were filtered in the countries case-studies that controlled for origin-year fixed effects, for instance in Figure 2.2, Panel B and C (impact of payroll tax exemptions in Luxembourg) and Figure 2.5, Panel B and D (impact of the German minimum wage). The specification in column (15) introduces a origin-year fixed effect, thus exploiting variations in costs within a given origin-destination pair and year. Controlling for unobserved time-varying origin and destination characteristics ensures that even if tax or minimum wage reforms were endogenous, this does not necessarily pose a threat to identification. As in the reduced-form analysis, the origin-year fixed effect filters-out all general equilibrium changes in supply and wages of posted workers that could be correlated with cost variations. As can be seen in column (15), the estimated coefficients become smaller than the coefficients in column (14),

[15] Data on bilateral posting flows are, however, less likely to be affected by zero flows compared to standard goods and services export flows, as there is no minimum reporting threshold for postings.

suggesting that general equilibrium effects do occur and may bias the estimates upwards. The estimated trade-migration elasticity remains large and statistically significant, with a point estimate of 1.1 (0.19). This estimate is strikingly similar to the reduced-form estimate exploiting the same type of bilateral variation and including a similar set of controls and fixed-effects, presented in the bottom left panel of Table 2.1.

In line with the theoretical framework, the empirical analysis shows compelling evidence of large international mobility responses to taxes through cross-border supply of services. Tax policy matters for the geography of trade-in-services. Specifically, payroll tax or labor cost exemptions granted to foreign suppliers of services causally affects international trade-migration flows with an elasticity above one. While exploiting different datasets, different tax and minimum wage reforms and different contexts, country case-studies and theory-consistent estimations yield point estimates that are remarkably cloe, with point estimates ranging from -.8 to -3. Using the median estimate with the preferred specification, a one percent labor cost cut in a given country increases flows of workers sent from this country by roughly 1.1 percent. One of the appeal of "gravity-grounded" estimates is to be directly comparable to similar estimates in the literature, focused on different types of flows, and different policy variations. Figure 2.6 summarizes prominent papers and their estimates of international migration responses to changes in income taxes (blue dots) and international trade flows responses to changes in trade costs (dark blue dots). The estimates of the trade-migration elasticities are plotted in dark pink. Interestingly, the posting elasticity is lower than the standard "trade in goods" elasticity, which is around 5 (Head and Mayer (2014)), and closer to the international migration elasticity, which is usually closer to unity in reduced-form estimates focused on top earners (Kleven, Landais, Munoz, and Stantcheva (2020)) and below unity for structural estimates considering the full European population (Caliendo, Opromolla, Parro, and Sforza (2017)). That is fully consistent with posting being simultaneously a trade and migration flow. Intuitively, those findings confirm that exporting workers is more costly than machines, meaning that trade-migration flows are less responsive to price shocks compared to trade-in-goods. But international mobility through trade-in-services is also more responsive to changes in costs than standard immigration, probably because its temporary nature and the intermediation by firms makes it easier to adjust to price shifters.Trade-migration flows are thus not only affected by different policies compared to standard trade-in-goods, they are also characterized by different responsiveness to these different policies.

Robustness Table B.1 augments the preferred specification (15) of the baseline model with additional tests. The first and second column start with robustness for alternative inference procedures. Column (1) shows the estimates when clustering standard errors at the origin-destination level, while column (2) accounts for twoway clustering at the origin-year and destination-year level. The trade-migration elasticity is still precisely estimated, and remains statistically significant at the one percent level. Column (3) repeats the preferred specification filtering all origin-year and destination-year shocks, including internal flows- the estimated coefficient is again very stable with a point estimate of -1.3(.256). Column (4) finally investigates potential heterogeneities in the trade-migration elasticity, restricting the gravity estimation to the Eurozone only.

2.6 Implications of Tax Reforms for Trade-in-Services

This section uses estimates of international trade-migration responses to tax differentials to quantify the tax revenue and mobility implications of changing how cross-border supply of services is taxed. Threy key ingreadients allow me to infer the quantitative implications of international tax reforms for trade: the structure of the model, the estimates of the trade-migration elasticity, and detailed data on current flows of suppliers of services within the EU.

Any reform regarding additional payroll taxes or labor cost imposed on workers posted from country i to j induces a change in the term $w_i(1+\tau_i+a_{ij})$ that captures the cost of posting workers from i to j. Denoting x' the value of the variable after the reform, the effect of the reform on bilateral posting flows, abstracting from general equilibrium effects (e.g keeping multilareral resistance and income term constant) can be written as:

$$\frac{S'_{ij}}{S_{ij}}|_{\Phi'_j=\Phi_j} = \left(\frac{c'_{ij}}{c_{ij}}\right)^{-\theta} = \exp\left(-\theta\left\{\log(c'_{ij}) - \log(c_{ij})\right\}\right) \tag{2.8}$$

The change in trade-migration flows following a tax reform depends on two parameters: the magnitude of the implied change in cost (c'_{ij}/c_{ij}), and the responsiveness of those flows (θ). I use Equation (2.8) to simulate the direct effects of implementing a changes in the tax treatment of posting flows on overall mobility-dependent trade within the EU, abstracting from indirect effects. I view this exercice as a transparent and straightforward first-path way to approximate the effects of a labor cost reform on postings for pair of countries affected by the change in labor cost rules. I compute the change in labor cost induced by a given reform for each pair of origin-destination country, and feed these changes in Equation (2.8), together with my estimate of the posting elasticity θ.

Tax Reforms and Trade-in-Services To get to the policy implications of changing the tax treatment of trade flows, I focus on the "equal tax" reform that has been recently discussed at the European Parliament. Such *prevailing labor cost reform* aims at lowering tax dumping incentives by imposing that no employees sent abroad to supply services can pay a level of taxes below the one that is in place in the destination country. This reform solely focuses on non-wage component of labor cost, and still allows for total wage costs differences between workers from different origin countries because of different origin-specific wages, even after accouting for posting allowance and minimum legal wages requirements. The reform equalizes both payroll tax rates and the basis of social security contributions paid by employers. While the posting allowance is currently exempted from taxes in most European countries, payroll taxes will be computed using the effective wage paid to posted workers, including the compulsory posting allowance paid by sending firms.

The effects of this reform in terms of trade-migration flows and collected tax revenue on posted workers are presented in Figure 2.7 shows that imposing equal payroll taxes for workers posted from countries with lowest level of labor taxes would restrict substantially internationally mobile services within the EU, with an average posting decrease of 30% over the period 2007-2017, accounting for 0.6% of current EU GDP. This overall decrease in postings following the reform masks important discrepancies in which sending countries are mostly affected by the change in posting rules. Country pairs with the current highest tax differential would experience the largest change in their exchange of posting services. For instance, Bulgaria would send 80% less posted workers abroad relative to the pre-reform level.[16]

2.7 Concluding Remarks

This chapter shows that tax competition can affect the international mobility of workers across borders through trade-in-services. Combining novel exhaustive administrative data covering all European countries with exogenous tax reforms, I show that tax differentials matter for the international mobility of workers sent abroad by their employer to supply services. The estimated trade-migration elasticities are large, with estimates around 2 in the reduced-form settings and around unity for structural estimates. Those findings have two main implications (i) international mobility responses to tax differentials in a globalized world are larger than previously thought because of this novel trade channel and (ii) tax competition matters for the geography of trade-in-services. When trade is liberalized in a tax competition world, tax arbitrage determines which countries export and import services, rather than differences in productivity or factors endowments. Governments and policy makers should also consider international trade, in addition of standard international mobility of workers, when seeking to set optimal taxes on workers. Those conclusions hold for countries that allow interstate trade-in-services while allowing states to set different taxes and regulations on workers.

[16] Equation (2.8) evaluates the "partial trade impact" of the reform, and omits general equilibrium effects that may have additional implications. Third-country effects through the adjustment of the multilateral resistance term Φ_j are not taken into account. For instance, increasing the taxes on workers posted from Poland to France may reallocate part of the demand from French customers to workers posted from other countries. Potential income and expenditures changes that follow a change in posting costs are also ignored in the partial approach. The estimates of the structural elasticity θ presented in Table 2.2 neutralize those reallowance and adjustment effects, capturing the pure mobility effects of wage costs on posting flows. In the counterfactual scenarios that evaluate changes in posting costs through tax reforms, the structure of the model can be used to solve for the indirect effects of the changes in costs on multilateral resistance terms and incomes.

Alberto Abadie, Alexis Diamond, and Jens Hainmueller. Synthetic control methods for comparative case studies: Estimating the effect of californias tobacco control program. *Journal of the American Statistical Association*, 105(490):493–505, 2010a.

Alberto Abadie, Alexis Diamond, and Jens Hainmueller. Synthetic control methods for comparative case studies: Estimating the effect of californias tobacco control program. *Journal of the American statistical Association*, 105(490):493–505, 2010b.

Ufuk Akcigit, Salomé Baslandze, and Stefanie Stantcheva. Taxation and the international mobility of inventors. *American Economic Review*, 106(10):2930–81, 2016.

James E Anderson and Eric Van Wincoop. Gravity with gravitas: A solution to the border puzzle. *American economic review*, 93(1):170–192, 2003.

Costas Arkolakis, Arnaud Costinot, and Andrés Rodríguez-Clare. New trade models, same old gains? *American Economic Review*, 102(1):94–130, 2012.

Kyle Bagwell and Robert W Staiger. An economic theory of gatt. *American Economic Review*, 89(1):215–248, 1999.

Jagdish Bhagwati, Arvind Panagariya, and Thirukodikaval N Srinivasan. The muddles over outsourcing. *Journal of Economic perspectives*, 18(4):93–114, 2004.

Lorenzo Caliendo, Luca David Opromolla, Fernando Parro, and Alessandro Sforza. Goods and factor market integration: a quantitative assessment of the eu enlargement. Technical report, National Bureau of Economic Research, 2017.

Arnaud Costinot and Andrés Rodríguez-Clare. Trade theory with numbers: Quantifying the consequences of globalization. In *Handbook of international economics*, volume 4, pages 197–261. Elsevier, 2014.

Michael P. Devereux and Rachel Griffith. Evaluating tax policy for location decisions. *International Tax and Public Finance*, 10(2):107–126, 2003.

Jonathan Eaton and Samuel Kortum. Technology, geography, and trade. *Econometrica*, 70(5):1741–1779, 2002.

Jonathan Eaton, Samuel S Kortum, and Sebastian Sotelo. International trade: Linking micro and macro. Technical report, National bureau of economic research, 2012.

Joseph Francois and Bernard Hoekman. Services trade and policy. *Journal of economic literature*, 48(3):642–92, 2010.

Li Gan, Manuel A Hernandez, and Shuang Ma. The higher costs of doing business in china: Minimum wages and firms' export behavior. *Journal of International Economics*, 100:81–94, 2016.

Roger H. Gordon and James R. Hines. International taxation. In A.J Auerbach and M. Feldstein, editors, *Handbook of Public Economics*, volume 4, pages 1935–1995. Elsevier: New York, US, 2002.

Rachel Griffith, James Hines, and Peter Birch Sørensen. International capital taxation. In A. Stuart, T. Besley, R. Blundell, S. Bond, R. Chote, M. Gammie, and P. Johnson, editors, *Dimensions of Tax Design: the Mirrlees Review*. Oxford University Press, Oxford, 2010.

Keith Head and Thierry Mayer. Gravity equations: Workhorse, toolkit, and cookbook. In *Handbook of international economics*, volume 4, pages 131–195. Elsevier, 2014.

Keith Head and Thierry Mayer. The united states of europe: A gravity model evaluation of the four freedoms. *Journal of Economic Perspectives*, 35(2):23–48, 2021.

Chang-Tai Hsieh and Esteban Rossi-Hansberg. The industrial revolution in services. Technical report, National Bureau of Economic Research, 2019.

Henrik Kleven, Camille Landais, Mathilde Munoz, and Stefanie Stantcheva. Taxation and migration: Evidence and policy implications. *Journal of Economic Perspectives*, 34(2):119–42, 2020.

Henrik J. Kleven, Camille Landais, and Emmanuel Saez. Taxation and international migration of superstars: Evidence from the european football market. *American Economic Review*, 103(5):1892–1924, 2013.

Henrik J. Kleven, Camille Landais, Emmanuel Saez, and Esben A. Schultz. Migration and wage effects of taxing top earners: Evidence from the foreigners' tax scheme in denmark. *Quarterly Journal of Economics*, 129(1):333–378, 2014.

Henrik Jacobsen Kleven. Bunching. *Annual Review of Economics*, 8:435–464, 2016.

Etienne Lehmann, Laurent Simula, and Alain Trannoy. Tax me if you can! optimal nonlinear income tax between competing governments. *Quarterly Journal of Economics*, 129(4):1995–2030, 2014.

Clément Malgouyres and Thierry Mayer. Exports and labor costs: evidence from a french policy. *Review of World Economics*, 154(3):429–454, 2018.

Mathilde Muñoz. Do european top earners react to labour taxation through migration? 2019a. Working Paper.

Mathilde Muñoz. Trading non-tradables: The implications of europe's job posting policy, 2021.

Ralph Ossa. A "new trade" theory of gatt/wto negotiations. *Journal of Political Economy*, 119(1):122–152, 2011.

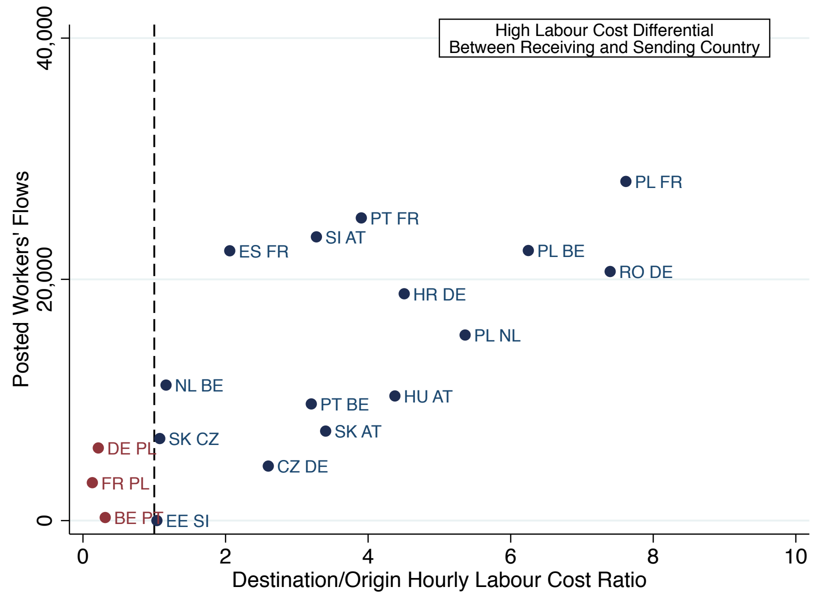
Emmanuel Saez, Joel Slemrod, and Seth Giertz. The elasticity of taxable income with respect to marginal tax rates: A critical review. *Journal of Economic Literature*, 50(1):3–50, 2012.

JMC Santos Silva and Silvana Tenreyro. The log of gravity. *The Review of Economics and statistics*, 88(4): 641–658, 2006.

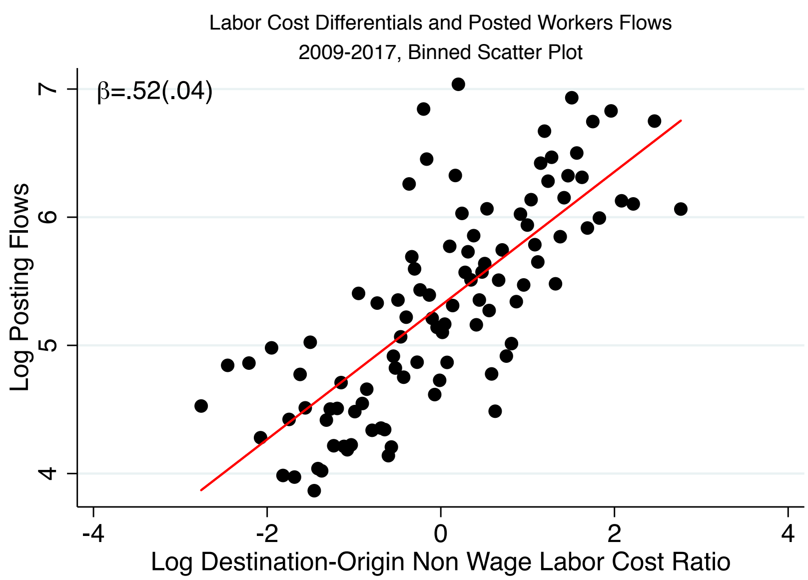
2.8 Figures And Tables

Figure 2.1: **Postings Flows and Labor Tax Differentials**

A. Bilateral Flows and Labor Cost Ratio



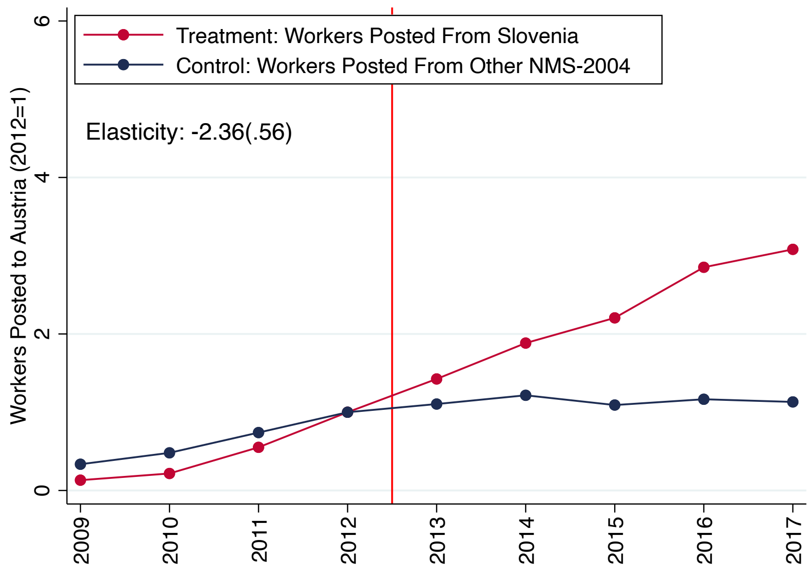
B. Steady-State Correlation



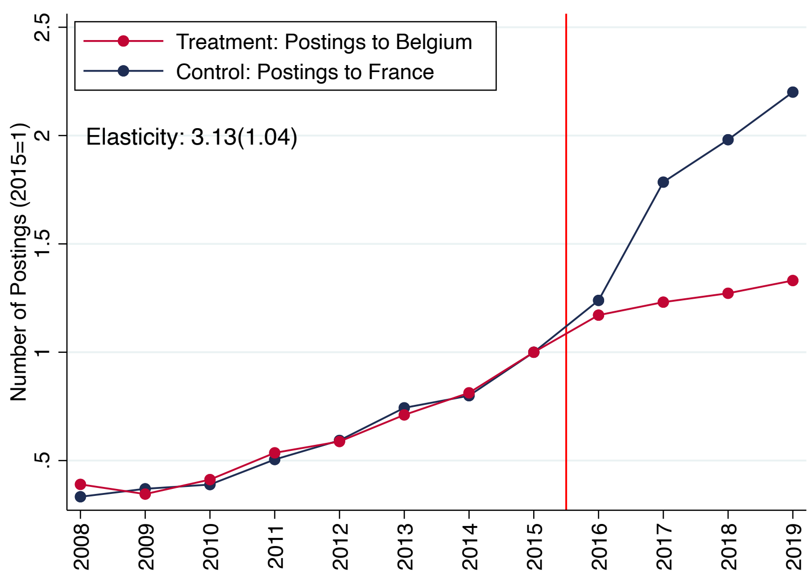
Notes: Posted workers pay origin-level labor taxes and are exempted from destination-level payroll taxes. The figure depicts the steady-state correlation between bilateral posting flows and destination-origin payroll taxes differentials for the period 2009-2017. The figure is based on the full matrix of bilateral posting flows within the EU merged with data on employers' payroll tax cost for 2009-2017. Posting flows are measured by mandatory E1/A101 social security forms that posted workers must hold when providing a service abroad, available at the origin-destination level each year for 2005-2017. Data on employers' non-wage labor cost (social security contributions and other labor taxes) are from annual Eurostat Labor Cost Indexes and are available for 2009-2017. The top panel plots, for some destination-origin pairs, the average raw level of posting flows against the average destination-origin payroll tax ratio over the period. A large destination-origin non-wage labor cost ratio means the sending country is characterized by much lower level of payroll taxes than the receiving country. The black dotted line depicts country pairs with similar levels of payroll taxes. The bottom panel generalizes this relationship by plotting the binned scatter plot of log bilateral posting flows against the log of the destination-origin non-wage labor cost ratio for all country pairs and all years. The reported coefficient is the cross-sectional correlation between log posting flows and log labor cost ratio for the period 2009-2017.

Figure 2.2: **Effect of Payroll Tax Reforms on Posting Flows**

A. Employers' Labor Cost Cut in Sending Country (Slovenia)

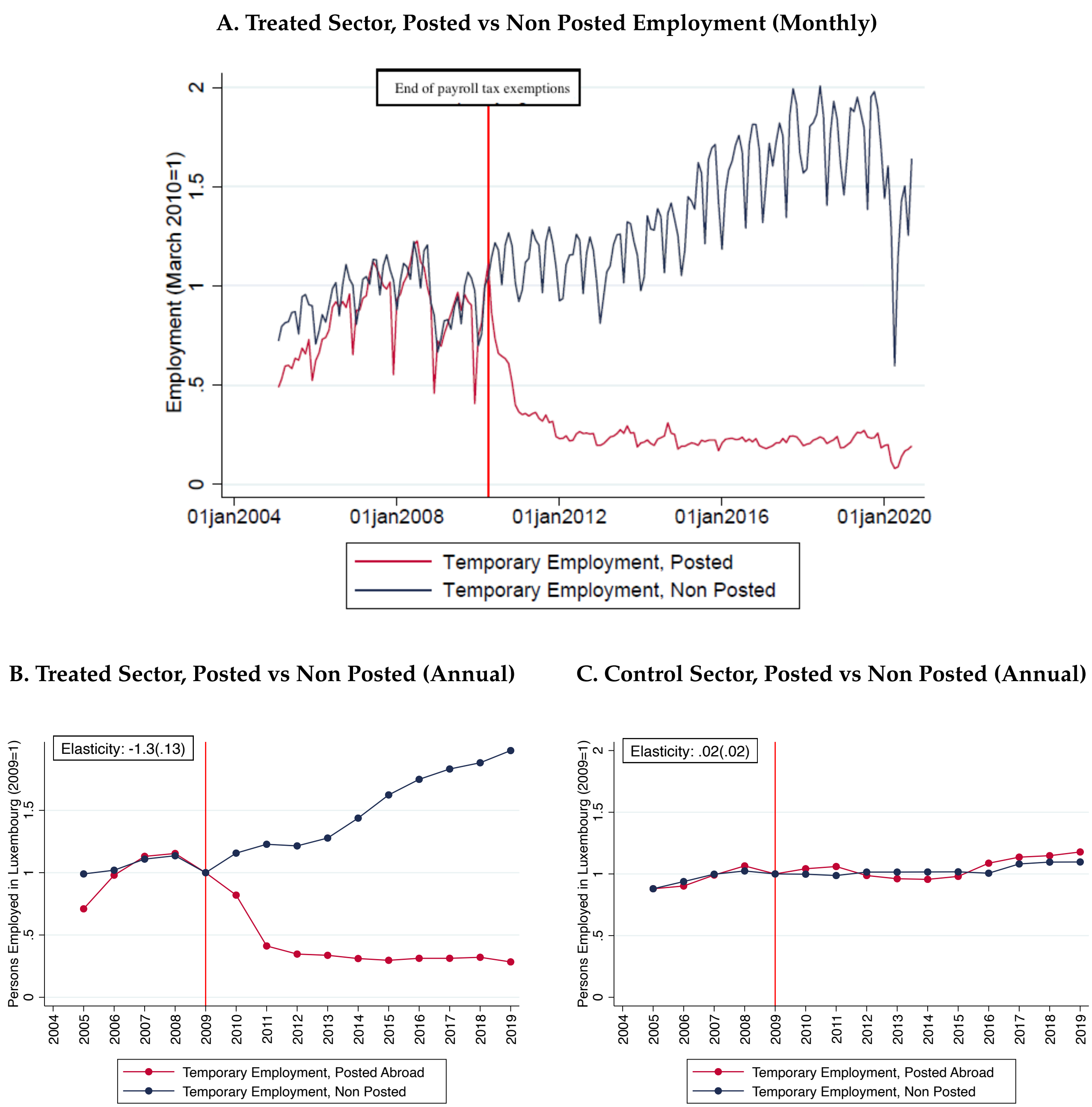


B. Employers' Labor Cost Cut in Receiving Country (Belgium)



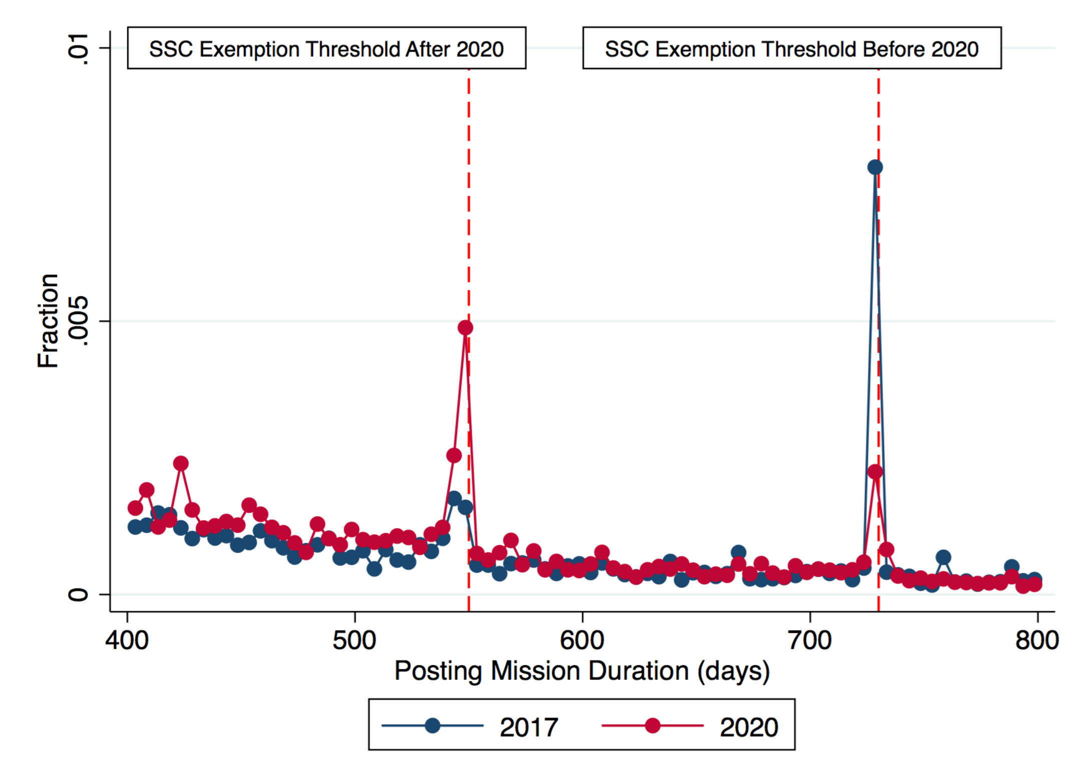
Notes: Posted workers pay origin-level labor taxes and are exempted from destination-level payroll taxes. This figure describes how posting flows are affected by exogenous labor cost reforms, exploiting two quasi-experimental changes in employers' labor cost in one of the main sending countries (Slovenia) and one of the main receiving countries (Belgium). A reform implemented at the end of 2012 in Slovenia decreased the labor cost of workers posted from the country by capping employers' social security contributions at 40% of the average Slovenian wage. Panel A shows how postings sent by Slovenia (treated, red series) evolved compared to posting flows from comparable countries (control, blue series) before and after the policy-induced change in labor cost. A reform implemented in Belgium in 2015 decreased Belgian employers' social security contributions by 8 percentage points. Panel B shows how postings received by Belgium (treated, red series) evolved compared to posting flows to comparable countries (control, blue series) before and after the policy-induced change in labor cost. All series are normalized to one the year before the implementation of the labor tax cut.

Figure 2.3: **Effects of Changing Payroll Tax Exemption Rules on Trade-Migration Flows**



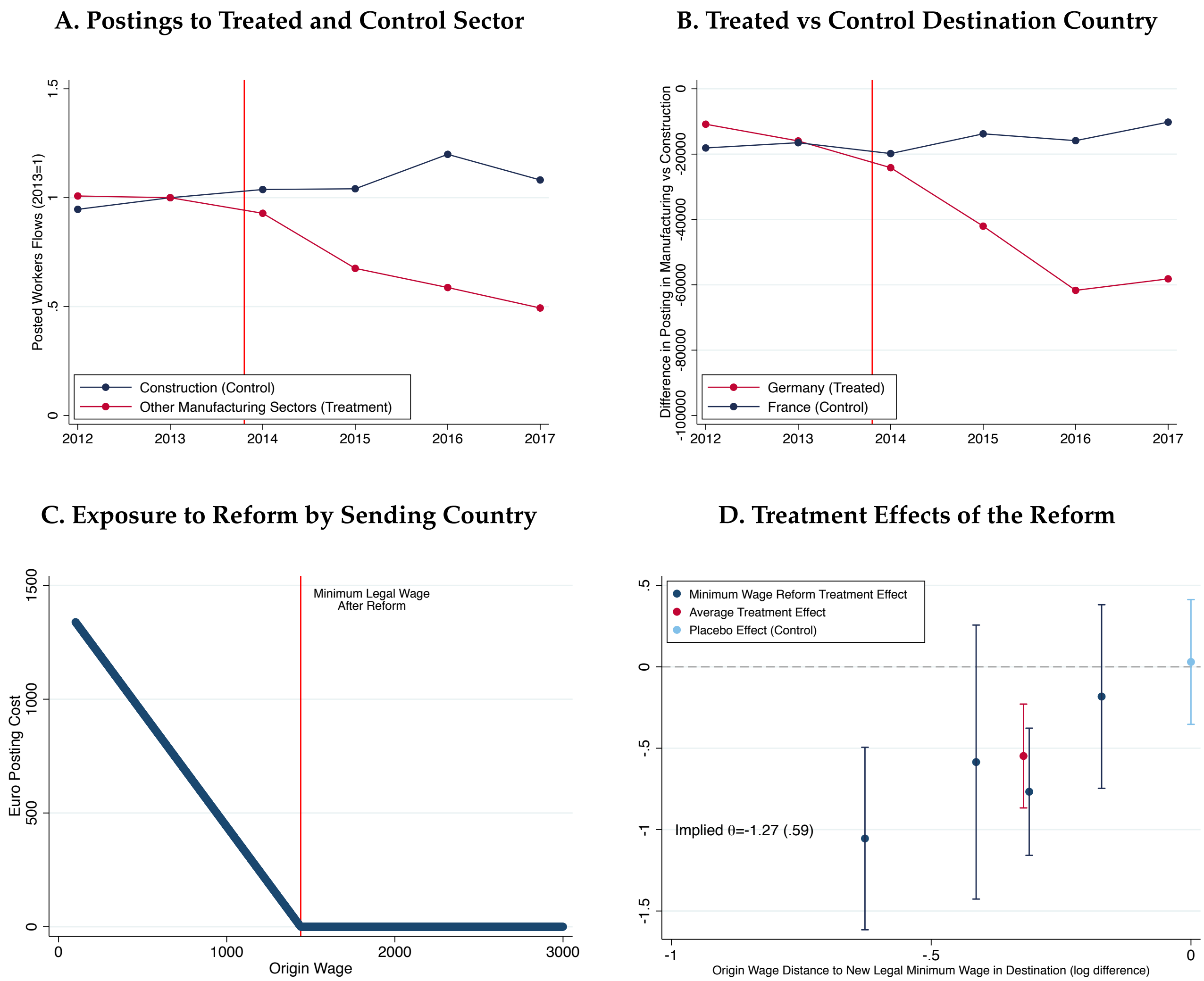
Notes: This Figure shows the effects of restricting posting-specific payroll tax exemptions. I study a reform that restricted labor cost exemptions granted for workers posted from temporary agencies located in Luxembourg. The reform was implemented in May 2010 and described in Appendix 2.4. To study this reform, I use exhaustive linked employer-employee data covering all job spells in Luxembourg from 2002 to 2020, merged with exhaustive mandatory posting declarations filed by Luxembourgish employers for 2004-2020. Panel A shows the monthly number of jobs (normalized to one in the month preceeding the reform) at temporary employment agencies located in Luxembourg performed abroad by posted workers (red line) or performed in Luxembourg (blue line), before and after the reform (vertical red line). Panel B repeats the analysis at the annual rather than monthly level. Panel C shows the same comparison for an alternative sector in Luxembourg (transport) that was much less affected by the 2010 reform, compared to temporary employment agencies.

Figure 2.4: **Bunching at the Payroll Tax Exemption Duration Threshold**



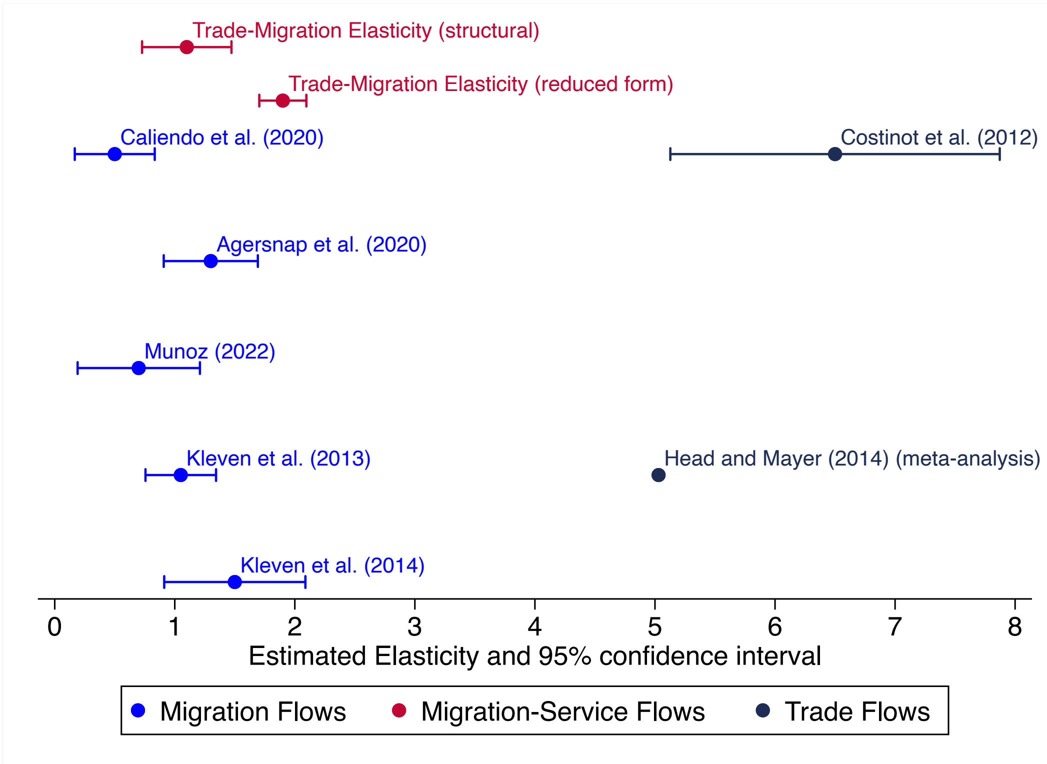
Notes: This Figure describes trade-ùigration responses to a change in destination-level labor cost exemptions granted to posted workers, on data covering all posting missions performed in France. A European directive was voted in 2018 and entried into force in 2020 (see Appendix 2.4 for details). Before the adoption of the directive, destination-level labor tax exemptions were granted to individuals posted for less than 24 months. In 2020, the maximum duration to benefit from payroll tax exemptions in the country of work was decreased to 18 months. I use the universe of mandatory posting declarations filed by foreign suppliers posting workers to France to show the distribution of posting mission duration (in days) by unique posted worker and starting year of the posting mission. The new and old labor cost exemption duration thresholds are depicted by red dashed vertical lines.

Figure 2.5: **Posting Flows Responses to Destination-Level Minimum Wage Reform**



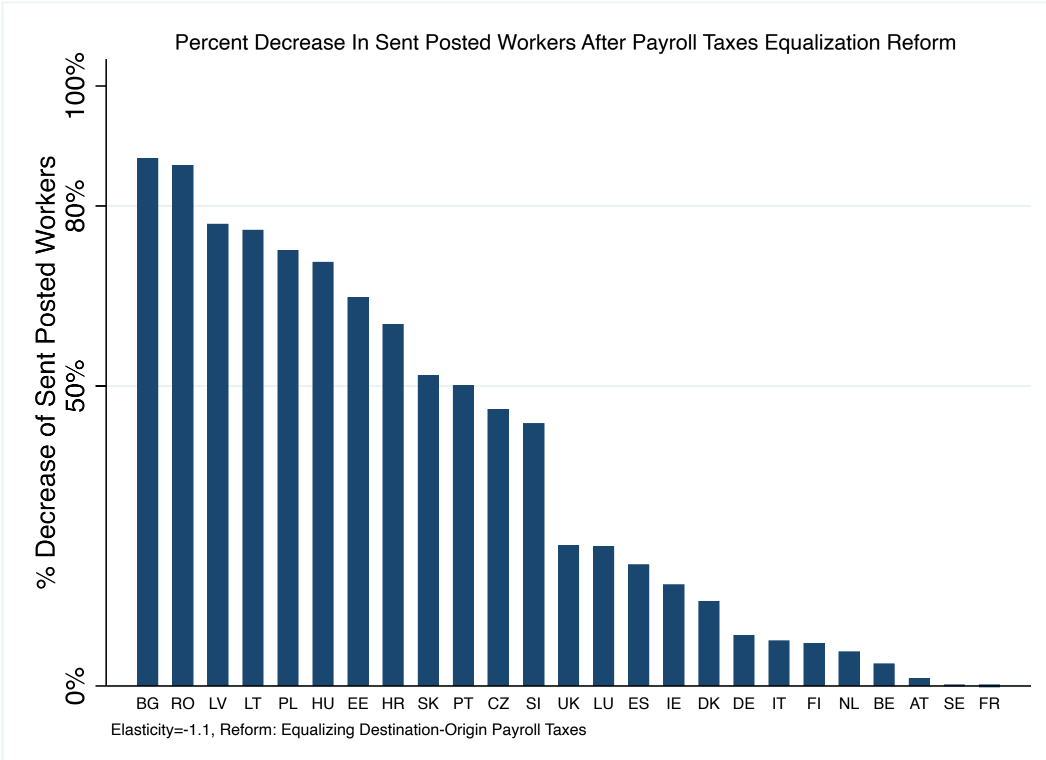
Notes: Posted workers pay origin-level labor taxes but cannot be paid under the receiving country's minimum legal wage. This figure decomposes posting flows responses to a minimum wage reform in Germany. A minimum legal wage was implemented in the meat industry sector in August 2014 and in all other sectors in 2015. The construction sector was regulated by a minimum legal wage since 1996 (applicable to posted workers), while other manufacturing sectors had collective agreements for German workers (not applicable to posted workers). The reform created an additional cost for postings to the treated (manufacturing) sector from countries with wages below the novel minimum legal wage in Germany (8 euros per hour). The analysis of the reform exploits E101/A1 mandatory posting forms with sectoral information, available from 2012 to 2017 for a subsample of sending countries: Poland, Luxembourg, Hungary, Czech Republic, Lithuania, and Romania. For these sending countries, I observe the universe of posting missions performed in each receiving country in each sector. Panel A shows how postings to Germany in treated (manufacturing) versus control (construction) sectors evolved after the implementation of the minimum legal wage in Germany. Panel B shows the sectoral differential evolution in the treated (Germany) versus control (France) receiving country. Panel D exploits heterogeneous exposure to the reform *within* the treated (manufacturing) sector, exploiting the kinked relationship between the sending country's wage level and additional cost implied by the reform, as shown in Panel C. Panel D shows the treatment effect (and 95% confidence intervals) of the minimum wage reform by exposure to the reform, controlling for origin-year, destination-year, and pair fixed effects. The coefficient compares flows of postings in the manufacturing (treated) sector, before and after the German minimum wage reform, to Germany and other countries, for each sending country that have more or less exposure to that reform. The blue coefficient plots the estimated treatment effect for the sending country with zero direct exposure to the reform, Luxembourg (minimum wage above novel German minimum wage). The resulting elasticity with respect to additional posting cost implied by the minimum wage implementation is 1.27(0.59).

Figure 2.6: **International Flows Responses to Changes in Costs**



Notes: This Table summarizes estimates of international flows elasticities in the literature. The international migration elasticities are the preferred estimates from Kleven, Landais, and Saez (2013) for European football players responses to top income tax rates, Kleven, Landais, Saez, and Schultz (2014) for top earners (top 1%) migration responses to a preferential tax scheme in Denmark, **?** for migrants responses to transfers in Denmark, Muñoz (2019a) for top earners (top 10%) migration responses to changes in top income tax rates in 21 European countries and Caliendo, Opromolla, Parro, and Sforza (2017) for within-EU migration responses to wage differentials based on a dynamic structural model.

Figure 2.7: **Changes in Exports of Services With End of Tax Competition**



Notes: The Figure displays counterfactual posting flows when labor taxes are equalized across domestic and posted workers. The counterfactual flows come from a back of the evelope estimation using estimated posting elasticities displayed in Table 2.2 and assuming no general equilibrium or indirect effects, and can thus be considered as a first approximation of the full effects of an "equal tax" posting reform.

Table 2.1: **Reduced-Form Estimates of Trade-Migration Responses to Payroll Tax and Minimum Wage Reforms**

	Description		
Panel A- 2010 Tax Arbitrage Reform			
Elasticity	-1.29***	-1.37***	
	(.134)	(.089)	
Tax variation	Origin	Origin	
Treated	Posted, Temp	Posted, Temp	
Control	Domestic	Domestic, Transport	
Dataset	IGSS Microdata	IGSS Microdata	
Observation level	Origin-Destination	Origin-Destination-Sector	
Model	Diff-in-Diff	Triple Diff	
Panel B- Slovenian Posted Bonus			
Elasticity	-2.36***	-1.63***	-2.32**
	(.561)	(.295)	(.686)
Tax variation	Origin	Origin	Origin
Treated	Slovenia	Slovenia	Slovenia
Control	Other NMS	Other NMS	Synthetic
Dataset	EU-A1	EU-A1	EU-A1
Observation level	Origin-Austria	Origin-Destination	Origin-Destination
Model	Diff-in-Diff	Diff-in-Diff	Diff-in-Diff
Panel C- Belgian Tax Shift			
Elasticity	-3.128**	-1.501*	-2.059**
	(1.041)	(.781)	(.661)
Tax Variation	Destination	Destination	Destination
Treated	Belgium	Belgium	Belgium
Control Country	France	France	Synthetic
Dataset	LIMOSA/SIPSI	EU-A1	EU-A1
Observation level	Origin-Destination	Origin-Destination	Origin-Destination
Model	Diff-in-Diff	Diff-in-Diff	Diff-in-Diff
Panel C- German Minimum Wage			
Elasticity	-1.575**	-1.265**	
	(.571)	(.594)	
Tax variation	Destination	Destination	
Treated	Germany, Manufacturing	Germany, Manufacturing binding min. wage in origin	
Control	Germany, Construction	Other Destinations, non-binding min. wage in origin	
Observation level	Origin-Germany-Sector	Origin-Destination	
Model	Diff-in-Diff	Triple Diff	

Notes: *p<0.10, **p<0.05, ***p<0.01. This table summarizes the reduced-form estimates of the trade-migration elasticity with respect to payroll cost of posted workers, using different quasi-natural experiments detailed in the text.

Table 2.2: **Elasticity of Posting Flows to Policy-Induced Labor Cost Changes**

Panel A: Full Gravity Estimation								
Regressor: Log Payroll Taxes	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
Posting Elasticity ($-\theta$)	-.71***	-.75***	-.66***	-1.2***	-1.2***	-.75**	-1.1***	
	(.20)	(.21)	(.21)	(.20)	(.21)	(.33)	(.38)	
Regressor: Log Total Wage Cost	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Posting Elasticity ($-\theta$)	-.78***	-.82***	-1.2***	-1.4***	-1.4***	-.97***	-2.4***	-1.1***
	(.23)	(.24)	(.15)	(.25)	(.27)	(.27)	(.47)	(.19)
Observations	4,665	4,455	4,723	4,665	4,455	4,723	4,723	4,667
Origin-Destination FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Destination $\times$ Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Origin $\times$ Year FE	No	No	No	No	No	No	No	Yes
Weighted	No	No	No	Yes	Yes	Yes	No	No
Estimator	OLS	OLS	PPML	OLS	OLS	PPML	MPPML	MPPML
Internal Flows	Yes	No	No	Yes	No	No	No	No

Notes: *p<0.10, **p<0.05, ***p<0.01. Posted workers are exempt from labor taxes in the receiving country: all payroll taxes during the posting mission are paid in the sending country. Posted workers cannot be paid less than destination-level minimum wage: they must receive an additional posting allowance to match that "prevailing regulatory wage." It presents estimates of the structural gravity Equation (2.7) on the full matrix of bilateral posting flows within the EU merged with data on employers' labor cost for each country pair (origin-specific wage and payroll taxes combined with destination-specific posting allowance) for 2009-2017. The top panel uses payroll cost only as a regressor, while the middle panel uses total wage cost of posted workers as a regressor, following the model. Each column is from a separate regression. The dependent variable is the number of postings from i to j at time t (S_{ijt}); in log for specifications relying on a log-linear version of Equation (2.7) (OLS estimation); in levels for specifications relying on the multiplicative form of Equation (2.7) following Silva and Tenreyro (2006) ("PPML" Poisson pseudo maximum likelihood estimator); and in shares λ_{ijt} following Eaton et al. (2012) ("MPML" Poisson pseudo maximum likelihood estimator with trade shares as dependent variable). All specifications include destination-origin fixed effects, a dummy equal to one if mobility rules between country i and j changes at time t, and a destination-year fixed effect to control for the multilateral resistance structural term (Φ_{ijt}). Columns (1) to (7) exploit variations in (log) employers' payroll taxes only, while Columns (8)-(14) exploit variations in (log) total employers' labor cost. Weighted regressions use total population in sending countries to weight observations. Robust standard errors are clustered at destination-year level and are displayed in parentheses.

Chapter 3

Do European Top Earners React to Taxation Through Migration?

3.1 Introduction

The public discourse on tax progressivity often emphasizes mobility responses to higher tax rates rather than standard labour supply effects. Most top income tax reforms are usually followed by fierce debates on the expected emigration of top earners. Because it is more salient than other margins of responses to taxes, tax-driven mobility sheds light on the deadweight cost of tax reforms. Accordingly, the threat of high wage earners' emigration has been one of the main argument against more progressive tax schedules.

Is this public debate on top earners' migration responses to taxation justified by the empirical evidence? To what extent do top taxpayers vote with their feet, and what are the implications of such responses in the absence of tax cooperation? In this paper, I use the unique laboratory provided by the European Union, an integrated union with low internal barriers to mobility but substantially different taxation on top earners, to answer these questions. This paper provides the first systematic evidence on *international* migration responses to personal income tax rates for a *representative* population of top taxpayers.

In spite of growing attention devoted to top earners' tax-driven mobility, there is still very little empirical evidence on the effect of taxation on the international mobility of individuals. Two empirical challenges can explain the paucity of empirical research in this area. First, there is a lack of international micro data with joint information on individuals' residential choices and taxes paid. Second, identifying the causal effect of taxes on location choices is challenging, because tax reforms and migration decisions may be correlated for many other reasons.

Three contributions in the literature managed to overcome some of these challenges, either by focusing on specific occupations with available residence and income individual-level data or by focusing on a reform targeted towards high skilled immigrants. Kleven et al. (2013) study the migration responses of football players to income tax differentials in 14 European countries for the period 1996-2008 exploiting variations created by the Bosman ruling and the implementation of specific tax schemes. Akcigit et al. (2016) use individual data on inventors for eight OECD countries for the period 1977-2000 and exploit the differential effects of top tax rates on inventors with different propensity to be treated by these changes. Finally, Kleven et al. (2014) use a specific tax scheme targeting high income in Denmark to estimate how foreigners responded to the reform. These papers take a first step in providing credible estimates of international migration responses to taxation, and establish that superstars' location choices are indeed affected by personal income tax rates. However, these studies focus on very specific occupations and the validity of their estimates for the entire top earners populations can be challenged. As emphasized in the recent survey of the literature by **?**, there is still a lack of evidence on tax-driven international migration for broader populations, a necessary parameter to better assess the tax policy implications of migration responses.

This paper aims to fill this gap. I propose an estimation of migration responses to top earnings tax rates for the entire top ten percent of earners in 21 European countries that addresses the two main empirical challenges described before.

I first overcome the *data challenge* by leveraging a newly constructed detailed individual-level dataset on mobility covering a representative sample of the overall European population, building on the largest European-wide survey (European Labour Force Survey: EU-LFS). The data allow me to track residence choices of taxpayers at different earnings levels in the European Union over the period 2009-2015. I combine this dataset with collected data on top personal income tax rates built from the OECD Taxing Wages.

In order to address the *identification challenge*, my main estimation strategy exploits the differential effects of changes in top income tax rates on location choices of top earners and individuals with lower earnings levels within a given country and year. This strategy allows me to filter-out unobserved country-specific shifts that are correlated with top tax rates changes and mobility patterns of individuals' affected or not affected by top tax rates reforms.

I start the analysis by describing new empirical facts on within-EU cross-national mobility. I build a novel mobility measure based on the EU-LFS that allows me to study individuals' mobility within Europe since 1987. I show that geographic mobility within the European free movement area has been rather stable from 1990 to 2005, and has increased twofold since then. This stylized fact is contrary to what has been observed in the US for the same period, where internal migration rates have been continuously decreasing since 2000 (Molloy et al. (2011)). I show that there are large heterogeneities driving geographic mobility within Europe, and that the composition and the evolution of mobile populations differ widely across Member States. I discuss how these differences may translate into differences in top earners' tax base sensitivity to top tax rates changes across European countries.

I then turn to the analysis of the effects of top tax rates changes on top earners' mobility. I perform the analysis at two, successively more detailed levels. I start the empirical analysis by investigating the correlations between top tax rates and top earners' mobility at the aggregated level. I find that after accounting for time and country invariant characteristics, there is a positive correlation between the top retention rate and the share of top earners who locate in one country. Consistent with the prediction of a simple model of top earners' location choices, I show that the number of top earners who move from one European country to another is systematically significantly affected by changes in the top tax differentials between the two countries. By focusing on changes over time, within a given country pair, the model absorbs all time-invariant factors that can shift the demand and supply of top earners across countries. In accordance to my main estimation strategy, I show that bilateral migration flows of individuals with lower earnings levels are not affected by top tax rates differentials variations. I confirm this finding by focusing on a country-specific reform that changes the top marginal tax rates for top earners. Comparing immigration to the treated and control country built using the **?** methodology, I show graphical evidence that the number of foreign top earners diverges from the control country after the change in top income tax rates, leading to a reduced-form migration elasticity of 3.2. In comparison, I find no evidence that the number of foreign bottom earners not dreictly affected by the top tax changes has evolved differently in the treated and control country, before and after the change in top income taxes.

A large part of mobility patterns are likely to be driven by unobserved heterogeneities in individuals' characteristics and abilities. To control for micro-level determinants of mobility decisions, I exploit the individual dimension of my data and turn to the estimation of a full-fledged multinomial model. The multinomial logit model allows me to estimate the effect of an increase in the net-of-tax rate in a given country on the probability of an individual locating in this country. My estimation strategy controls for both unobserved counterfactual wages and other unobserved migration determinants that could be correlated with individuals' location choices and changes in top tax rates. The EU-LFS provides me with a rare opportunity of measuring directly individuals' ability and characteristics through extensive information on demographics and individuals' past and current employment. I take advantage of the multinomial logit estimation features that allows me to interact these rich individual-level measures of ability with country fixed-effects, thus controlling for differences in wages premium across countries. The estimation also controls for country fixed effects, year fixed effects and country-specific linear trends that filter-out time-invariant factors, agrgegate time shocks and country-specific longer-term evolutions in mobility and incomes. To control for the last source of potential endogeneity that lies in country-year shifts correlated with top tax rates and location choices, I exploit the differential effects of changes in the top tax rates on the location choices of top ten percent earners and individuals in lower earnings deciles. As in a standard difference-in-differences setting, this allows me to use the coefficient estimate of the control group to differentiate-out the effects of unobserved country-year factors that affect similarly the top ten percent of earners and individuals with lower earnings.

I find that top earners' location choices are significantly affected by top tax rates. Across all specifications, the coefficient on log net-of-tax rate is positive, large and stastistically significant for top earners, and declines monotonically with income capturing well differences in propensity to be treated by top tax rates across earnings levels. The estimates are robust to the inclusion of country-year fixed effects that control for all unobserved country-specific shocks. I use the coefficients from the micro-level analysis to estimate top earners' location elasticities with respect to the top net-of-tax rate. I provide the effects relative to several possible control groups for the top ten percent. At the lower end, using the 8th decile of earnings as a control group yields an elasticity of the number of top earners with respect to the net-of-tax rate of 0.15 that is statistically significant at the one percent level. Using the 6th-7th deciles, the median decile or the bottom fifty percent as control groups yields elasticities of respectively 0.27, 0.25 and 0.35, all significant at the one percent level. Considering the 8th decile as the control group, the results imply that if the average European country decreases its top tax rate by 10 percentage points from a level of 60 percent, the number of top earners in this country would increase by roughly 2 percent. While European top earners' location choices are significantly affected by top marginal tax rates, the magnitude of the tax-driven migration effect on the total tax base is thus relatively small. I confirm this finding by laying out a simple theoretical framework that I use to calibrate the tax-revenue effects of top tax changes in Europe in the presence of top earners' migration responses to taxation. I find that while being statistically different from zero, the estimated elasticities are not large enough to compensate alone a decrease in current levels of top tax rates in Europe.

There are large heterogeneities in top earners' sensitivity to top taxes in location decisions that are likely to drive the overall estimated elasticity. Consistent with the findings of Kleven et al. (2013), Kleven et al. (2014) and Akcigit et al. (2016), I estimate that the elasticity with respect to the net-of-tax rate is very large for foreigners, and lies between 0.7 and 1.7. I find that top earners working in banking and insurance are also more likely to take advantage of top tax differentials when choosing where to locate compared to top earners working in more constrained occupations like public administration or defence. These heterogeneities in individuals' sensitivity to taxes may lead countries with different tax bases composition to be affected differently by top earners' tax-driven migration. For instance, abstracting from other margins of responses, I find that the top earners' tax base in Germany is two times less elastic to changes in top marginal tax rates compared to the top earners' tax base in France or Luxembourg.

I then perform extensive robustness checks and extensions on these benchmark results. First, I investigate the role of firm-level chacrateristics on individuals' migration responses to taxation. Second, I use a French administrative dataset that merges individuals' tax data with the French part of the EU-LFS to show that my mobility measure is consistent and not biased by mismeasurement. Third, I show that my benchmark results are robust to the inclusion of preferential tax regimes targeted on foreigners satisfying specific eligibility rules. Finally, I show that there is no evidence of shifts from self-employment to self-employment that would be correlated with top tax rates changes and top earners' location choices.

Related Literature This paper relates to the scarce, but growing, literature on migration responses to taxation recently surveyed in **?**. On international migration responses to taxation, Kleven et al. (2013), Akcigit et al. (2016) and Kleven et al. (2014) found that superstars location choices are significantly affected by personal income tax rates. This paper adds to those studies by showing that this finding holds for a more general definition of top earners, and by providing sufficient statistics estimates that can be used for much broader policy recommendations. Getting the magnitude of those responses for a representative population matters, as those elastiticities are key parameters that determine the optimal tax formula in an open economy (see Mirrlees (1982),Wilson (1992) and Lehmann et al. (2014)).[1]

[1]See Hamilton and Pestieau (2005), Piaser (2007) and Lipatov and Weichenrieder (2010) for the Stiglitz (1982) version of the Mirrlees with discrete types of agents in an open economy and Seade (1977), Diamond (1998), Brewer et al. (2010) for a Mirrlees open economy with continuous distribution of skills.

This paper is also closely related to the small but growing literature on within-country migration, that exploits local variations in tax rates to estimate the causal effect of tax differentials on location choices (Liebig et al. (2007) and Schmidheiny and Slotwinski (2018) in Switzerland, Young and Varner (2011); Young et al. (2016) in the US for millionaires, Agrawal and Foremny (2018) in Spain). Moretti and Wilson (2017) provide a central contribution by studying the effects of both personal and corporate income tax rates across US states on top inventors location choices within the country. In a recent study leveraging historical data on taxes and inventors, Akcigit et al. (2018) show that in the early 20th century, inventors' location choices within the US were also affected by changes in personal income tax rates. While compelling, those studies provide upper bounds for international migration responses to taxes, because within-country mobility is likely to adjust more quickly to policy changes.

As top earners might not react solely to taxation on income, there is a very scarce literature on the effect of wealth, property and inheritance taxes on mobility. Bakija and Slemrod (2004) show that higher state taxes have a small effect on the mobility of wealthy individuals across states in the United States. In a recent paper, Moretti and Wilson (2019) find that location choices of very wealthy taxpayers in the US are significantly affected by the estate tax. There also exist few papers that have investigated the effect of income tax rates on multinational location choices, such as Egger et al. (2013) who find that firms tend to locate their headquarters where top income tax rates are lower.

The rest of the paper is structured as follow. Section 3.2 describes the construction of the novel European tax-mobility dataset used in the estimation and documents stylized facts on European mobility. Section 3.3 lays out a theoretical framework of top earners' location choices used for the rest of the analysis and discusses the identification strategy. Section 3.4 empirically investigates the effects of top tax rates on top earners' migration in Europe at the aggregated level. Section 3.5 presents the result of the discrete choice model and calibrates the policy implications of the estimates and Section 3.6 presents additional mechanisms and robustness checks on the baseline estimates.

3.2 Data and Stylized Facts

3.2.1 The Mobility Data

My analysis is based on a large individual dataset on top earners mobility built from the largest Europe-wide survey covering persons in private households: the European Labor Force Survey (EU-LFS). The EU-LFS is conducted every year in all European member states and EFTA countries, and participation in the EU-LFS for surveyed individuals is compulsory in fourteen countries.[2] Labour force surveys (LFS) are implemented at the country level by national statistical institutes, and are then aggregated by Eurostat, which also corrects for non-response and applies weighting methods allowing to implement cross-country comparisons. The EU-LFS is regulated by law since 1973 and these legal grounds are a central element to ensure the quality

[2]The EU-LFS is implemented in the 28 members of the Union, the three EFTA countries (Switzerland, Norway and Iceland) and two candidate countries (former Republic of Macedonia and Turkey), and is compulsory in Belgium, Germany, Greece, Spain, France, Italy, Cyprus, Malta, Austria, Portugal, Slovakia, Norway, Switzerland and Turkey.

of these data.[3] As LFS are used by European countries to compute central economic indicators, such as the unemployment rate, very high attention is devoted to the quality of the data. As a result, the reliability and the representativity of the EU-LFS is remarkably high. To complement these data quality requirements, some member states use register data to complete and check the consistency of the data collected, especially regarding demographic variables such as gender, age, marital status or nationality of individuals. The EU-LFS dataset is described in more detail in the Data Appendix.

The EU-LFS is a repeated cross-section, where the sample of individuals surveyed each year is randomly drawn. It provides detailed information on demographic and social characteristics at the individual level for the year of the survey, and the year before, from 1987 to 2015. Individual information in the data include among others age, gender, country of residence, country of previous residence, occupation, previous occupation, employment status, employers' characteristics, marital status, country of birth, nationality, level and field of education. The survey is intended to cover the whole of the resident population, that are all persons whose usual place of residence is in the territory of the Member States of the European Union. Each individual surveyed in one member state will be defined as a resident of this member state if it satisfies the definition of long-term residence enforced by Eurostat. A person belongs to the resident population of a given country if he is physically staying, or intends to stay, on the economic territory of that country for a period of one year or more. As it is explicitely explained in the implementation guidelines of the survey: "This question ("How long do you intend to stay in this country") has to be explicitly asked to surveyed individuals who are new in the country where they are surveyed". If the intended length of stay is lower than one year, the individual is removed from the resident population and is not included in the survey. Because an individual residing for more than 183 days in one country becomes a tax resident of this country, the EU-LFS measures the number of individuals who chose to be tax residents in each member state in each year covered by the survey. In addition, people also have to provide information on their country of previous residence. The EU-LFS therefore allows me to capture permanent change in residence based on the 12-months rule, and to define movers as individuals who change their residence country between the year of the survey and the year before.[4] The robustness of the residence concept used by the EU-LFS allows me to estimate real changes in residence and to rule out worries related to change in taxable residence only, in contrast with within-country studies of mobility that exploit tax returns data.[5]

Selection of Top earners Since 2009, information on employees' level of monthly labor earnings is collected during the interview.[6] Individuals are asked to show payslips to confirm the information they pro-

[3]Regulation (EC) No 577/98. The implementation of a Labour Force Survey harmonized with European criteria is one of the requirement to enter as a new member state in the European Union. The European regulation stipulates explicit rules and common methodology to ensure the comparability of the results across member states.

[4]The annual reports on intra-EU mobility published by the DG Employment discuss the reliability of available data on mobility flows in the EU. They especially emphasize that because of the residence definition used by LFS, yearly mobility measures built from the EU-LFS are the most reliable to study long-term mobility within the European Union. Using administrative French tax data merged with the EU-LFS, I show in Section 3.6 that the mobility measure of the EU-LFS performs very well, as almost all new residents are matched to an income tax statement after their change of residence.

[5]See Agrawal and Foremny (2018) for a discussion of this issue in within-Spain movements measured through income tax data.

[6]Monthly labour earnings relate to the pay from the main job after deduction of income tax and national insurance contributions. It includes regular overtime, extra compensation for shift work, seniority bonuses, regular travel allowances and per diem allowances, tips and commission, compensation for meals.

vide during the interview. The national statistics institutes use the collected information on labour earnings to compute the earnings distribution for employees in each participating country, correcting for non response biases and survey sample weights, and attribute to each employee surveyed in the EU-LFS a decile of income. The information on the level of labour earnings is deleted by Eurostat from the micro files, and only the information on the decile of income is available for researchers. I use the information provided by the EU-LFS on decile of earnings for employees to select top earners' in my sample since 2009. I define as top earners individuals with labour income in the top decile of the earnings distribution of their residence country.

Table 3.1 provides descriptive statistics for the full population of employees surveyed in the EU-LFS for the estimation period 2009-2015, comparing top earners' characteristics with the average of the employees population. Individuals in the top ten percent of the labour earnings distribution are on average older and much more likely to be men and to be married, compared to the overall earnings distribution. Individuals in the top decile are highly educated, live in cities, have managerial responsabilities, work in bigger firms and have longer weekly work duration. The share of foreign born is lower among top earners' residents than in the average population, while the yearly geographical mobility rate has been higher for top earners than for individuals in lower earnings' deciles over the period 2009-2015. Top earners' population finally differ in their composition across European countries. Countries like Luxembourg or Belgium are characterized by a more international top earners' tax base compared to countries like Germany, Italy or Poland. Geographical origin and occupations of top earners also differ widely across Member States. These heterogeneities in top earners' tax base composition are likely to translate into differences in tax base sensitivity to top tax rates changes. I discuss this point later in the analysis.

Complementary Data on European Top Earners I complement my baseline mobility dataset build from the EU-LFS with additional individual-level European data on earnings levels from the European Survey on Living and Income Conditions (EU-SILC). The EU-SILC is a detailed individual-level annual European survey that gives precise information on various sources of income, such as monthly labor earnings, gross household income, and capital income and wealth taxes for the period 2005-2015. The main advantage of the EU-SILC dataset is that it shares a large set of common variables with the EU-LFS, and that these covariates are coded and defined in exactly the same way in the two surveys. In particular, the income variable used to build labour earnings decile in the EU-LFS is available in levels in the EU-SILC.[7] I take advantage of this feature to select individuals with labour income in the top decile of the earnings distribution of their residence country in the EU-SILC. This allows me to obtain a top ten percent sample defined in the same way than in the EU-LFS with detailed information on level of gross individual and household labour earnings for my estimation period.

[7]The EU-SILC does not provide information on past country of residence and is thus not exploitable for the mobility analysis.

3.2.2 Top Income Tax Rates

I collect data on top income tax rates across European countries. I construct yearly European top marginal income tax rates using data from the OECD Taxing Wages database. The final merged dataset on tax rates and mobility contains information for 21 European countries in the OECD.[8]

As outlined with more details in the theoretical framework exposed in the next SubSection 3.3.1, the relevant tax rate for migration decisions is the average tax rate on earnings. This is because location choices are driven by total tax liabilities paid in each potential location, that determine the total level of utility in each of these locations. Computing the effective tax rate of individuals included in the estimation sample would require detailed information on individuals' sources of income, wealth and household characteristics that are not available in my data, in addition to the exact level of earnings that is not observable. These limitations would be especially salient at the bottom of the distribution, where transfers largely affect individuals' tax burden, explaining partially why the literature has for now focused on migration responses of individuals at the top of the income distribution, where the inference of effective tax rates is easier.

I follow Kleven et al. (2013) and Akcigit et al. (2016) and use top marginal tax rates on personal income as a proxy for effective tax rates. Although top marginal tax rates are in general not equal to average tax rates because of the nonlinearity of the tax system, they should be strongly correlated to effective tax rates at the top of the income distribution.[9] Therefore, my baseline measure of taxation is the top marginal tax rate on personal income. It combines the central government and local marginal personal income tax rate at the earnings threshold where the top statutory personal income tax rate first applied, as collected by the OECD Taxing Wages Database.[10]

The first important advantage of the top marginal tax rate measure is that conditional on being in the top bracket, it is exogeneous to earnings, by contrast to the average tax rate. Since actual and counterfactual earnings are not observable, using an exogeneous measure of taxation allows, to a certain extent, to get rid of issues related to correlation between earnings in the destination country and effective tax rates paid in this country. As emphasized by the recent work conducted by Stantcheva (2020), the top marginal tax rate on personal income also presents the advantage to be a very salient tax instrument, which makes it a good tax measure for migration decisions. While individuals may be perfectly able to estimate their overall tax burden in their country of residence, they may be less apt to do so in alternative potential destination countries. By contrast, levels of marginal tax rates on personal income in the top tax bracket are very comparable across countries even when they are characterized by very heterogeneous fiscal and social regimes. The final advantage of using the top marginal tax rate on income is that it allows me to identify very clearly the threshold of top marginal tax rate treatment (top income tax bracket threshold) across member states. This is particularly useful to verify propensities to be treated by my top tax rate measure in my estimation

[8] The list of countries included in the analysis is: Austria, Belgium, Denmark, Croatia, Czech Republic, Estonia, Finland, France, Germany, Hungary, Italy, Latvia, Luxembourg, Netherlands, Poland, Portugal, Slovenia, Slovakia, Spain, Switzerland, United Kingdom. Norway, Greece, Sweden and Ireland did not provide suficient information either on income decile level or past residence and therefore cannot be included in the estimation sample. More details on the dataset creation are provided in the Data appendix.

[9] Kleven et al. (2013) show that estimated elasticities using top marginal tax rates and average tax rates are very similar.

[10] Data are directly made available to researcher through the OECD Taxing Wages Database https://stats.oecd.org/Index.aspx?DataSetCode=AWCOMP.

sample.

In order to document propensities to be treated by top marginal tax rates across countries, I leverage detailed individual-level European data on income provided by the EU-SILC. I use the information on individual wage to select individuals in the top ten percent of the earnings distribution in the EU-SILC.[11] Figure 3.2 shows the distribution of gross wage and gross household income of individuals in the top ten percent of the wage distribution in a selected sample of countries. The information of earnings' distribution within the top decile is combined with information on top marginal tax rate threshold in the country. In most countries, the top decile is entirely treated by the top marginal tax rate. In some countries, such as Belgium or Luxembourg, lower income brackets are also affected by the top marginal tax rate. Figure 3.2 thus emphasizes that the intensity of top marginal tax rate treatment within the top decile and in lower income brackets may vary across countries, depending on the progressivity of the income tax schedule. The estimation strategy will thus exploit differences in propensity to be treated, rather than a pure treatment effect above the top decile. I discuss this point in more details later in the analysis.

To consider variations coming from the overall tax code, I build an alternative measure of top income tax rates that combines the top marginal income tax rate on income with marginal social security contributions rates paid by employees and employers at the top of the income distribution that are also collected from the OECD Taxing Wages Database. I present the results using this broader measure of the top tax rate for my baseline estimation results. This approach however implies treating social security contributions as pure taxes, without taking into account how individuals may perceive the transfers linked to these contributions. Tax-benefit linkages could greatly vary across countries regarding the large heterogeneities across social insurance systems, and be correlated to location choices.

There may be some complications coming from specific foreign tax rules and regimes across countries that I am not able to account for given my data. For instance, an individual coming to France may ask to benefit from a 30% income tax exemption if he satisfies the eligibility criteria of the "*impatriates regime*". Depending on the unobserved individual's eligibility criteria and legal arrangements with the tax administration, this might lead to different effective tax rates. Because of similar data limitations, I follow Akcigit et al. (2016) and assume that to a first order the individual pays the regular top tax rate in place in the country where he resides. I however investigate the robustness of the estimates to imputing foreigners tax schemes eligibility in Section 3.6.[12]

There are finally other taxes that may influence migration decisions, such as capital gains taxes or wealth taxes. However, my estimation sample is limited to employees for which the main part of the total income is the ordinary personal income. This allows me to a first order to abtract from other forms of taxation and to focus on the effects of personal income taxation.

The identifying variations in top marginal tax rates are showed in figure 3.3. The figure shows that top

[11] As this information is defined similarly in EU-SILC and EU-LFS, and is the one used by Eurostat to compute individuals' earnings deciles in the EU-LFS, this allows me to obtain a sample of top earners comparable to my estimation sample, with additional information on earnings level.

[12] As documented in Section 3.6 the aggregate numbers available on the number of taxpayers benefitting from these regimes and the specificity of the eligibility criteria required by these schemes indicate that the potentially eligibile individuals represent a very small fraction of my overall estimation sample of European top earners.

income tax rates differ widely in terms of level between European countries. Top income tax rates have also evolved differently over the 2009-2015 period. For instance, as showed in Panel A, the top marginal tax rate has increased dramatically in France in 2011-2012 while top statutory rates in the neighbouring countries, Belgium and Germany, remained stable during the same period.

3.2.3 Stylized Facts on European Mobility

I use the information on current and past residence to track individuals' geographical mobility flows within Europe for the period 1987-2015. I also exploit data on residents' country of birth and citizenship available since 1998 to provide additional evidence on individuals' mobility within Europe over the period.

A first proxy of within-Europe mobility is captured by the evolution of foreign-born and non-citizen resident population in Europe, that measures the stock of individuals who moved across countries at some point in their life. The share of foreign-born residents in Europe is on average 12% over the estimation period and has been increasing since 2004 (Figure C.1). Interestingly the share of foreigners in the overall European population is not very different from what is observed for specific occupations like football players for which roughly 10% of workforce is foreign born according to Kleven et al. (2013).[13] Mobility measured as share of non-citizens residents is lower (8% on average), and has also been increasing over the past 20 years.[14] Roughly half of foreign born and non-citizen residents are natives from outside the EU, suggesting that freedom of movement contributes to 50% of overall European mobility. Mobility is not a phenomenon focused at the top, as the share of foreign-born residents among bottom earners is larger than the share of foreign-born residents at the top of the income distribution. European countries are very heterogeneous in terms of foreign population size and evolution as showed by Figure C.2. Some small countries like Luxembourg have especially large stocks of foreign residents (around 40%), by contrast to countries like Italy where this share is significantly lower.

I then exploit the information on individuals' past and current residence and focus on mobility flows in European countries. I define as movers individuals who were a resident of another country the year before the year of the survey. As the residence definition used by the EU-LFS requires for new residents an intention to stay of at least 12 months, this definition of cross-border mobility allows to robustly capture long term migrants. This provides me with a unique measure of individuals geaographical mobility within Europe that is fully comparable across countries and over time. Figure 3.1 shows the share of individuals who change their residence country each year, comparing this migration share for all moves and within-Europe moves only, since 1987 to 2015. The Figure allows to isolate some historical events that affected European mobility, such as the end of the communist era that led to a pick of migration to Western Europe in 1990, the Great Recession that stopped temporarily migrations in 2008 or the recent refugees crisis that partially explains the increase in non-European moves since 2015. Overall, what emerges from the descriptive data analysis is that within-Europe mobility has been continuously increasing since 2000, in contrast to what has

[13] See Table A.1 in the Appendix of Kleven et al. (2013) for country-level numbers.

[14] This figure is lower than the stock of foreign residents, because individuals who acquired the nationality of their residence country appear as nationals in the data.

been observed for the same period in the US. One advantage of the EU-LFS based migration measure is that it is directly comparable to within-US inter-state migration rates, computed from the CPS data using information on individuals who changed their state of residence between march of one year and march of the previous year. The large decrease in inter-state mobility in the US observed since 2000 has been interpreted by the literature as a sign of regional convergence.[15] In Figure 3.1, I show that Europe followed a very different path. Internal migration rates remain substantially different in levels (0.3% in Europe versus 1.5% in the US), a difference that can be explained by size differences between European countries and American states and by larger migration costs related to crossing country borders, compared to within-US mobility. However, in terms of trends, Figure 3.1 suggests that within-union mobility has been converging between the US and Europe over the past ten years.

3.3 Conceptual Framework and Identification Strategy

3.3.1 A Simple Model of Top earners' Mobility

My empirical strategy builds on a very simple model of top earners mobility within Europe. I consider an integrated zone with N member states where $n \in 1, ..., N$. There is a continuum K of taxpayers where $k \in 1, ..., K$. In the simple case where the European labour market of top earners is perfectly competitive, the before-tax wage in each country is entirely determined by individual's marginal product in this country w^k_{nt}. In country n, an individual has to pay a tax rate τ_{nt} on his total income at time t. In addition to the income earned, an individual receives an individual-country-specific utility benefit of locating as a tax resident in country n at time t Γ^k_{nt}. This benefit is person-specific and could include among others a preference for the origin country m (γ_{mn}), country-level characteristics such as the language or the quality of life (γ_n), time-specific shocks that could affect migration decisions (γ_t) and country-specific varying factors that affect residents' utility, such as economical changes or reforms (γ_{nt}). In addition to systematic factors, Γ^k_{nt} also captures the fact that location decisions are affected by an individual taste shock for country n e^k_{nt}. Total utility from choosing country n at time t is given by:

$$U^k_{nt} = u(w^k_{nt}(1 - \tau^k_{nt}) + \Gamma^k_{nt}) \tag{3.1}$$

Individuals make their migration decisions conditional on their labour supply choices. It follows that the individual k chooses to live in country n at time t if and only if:

$$u(w^k_{nt}(1 - \tau^k_{nt}) + \Gamma^k_{nt}) \geq \max_{n'} u(w^k_{n't}(1 - \tau^k_{n't}) + \Gamma^k_{n't}) \tag{3.2}$$

Equation (3.2) shows that individuals can move because of the level of taxes ($\tau^k_{nt} w^k_{nt}$), before-tax wages (w^k_{nt}), factors like amenities or economical conditions loaded in Γ^k_{nt} and individual taste shocks (e^k_{nt}). The migration condition also emphasizes that conceptually, location choices are driven by average tax rates,

[15] See Molloy et al. (2011) for a careful documentation of this empirical fact and plausible explanations of decreasing interstate mobility within the US.

rather than marginal tax rates, which are equivalent in the simplistic case of a linear tax schedule. In the empirical analysis, I will proxy the average tax rate by the top marginal tax rate, making the assumption that the effective tax rate for top earners is well approximated by the marginal tax rate in the top bracket, as in Kleven et al. (2013) and Akcigit et al. (2016). I consider an increasing and concave log linear utility function with respect to wages and taxes, such that the utility of living in country n at time t for individual k can be rewritten:

$$U_{nt}^{k} = \alpha log(1-\tau_{nt}) + \alpha log(w_{nt}^{k}) + \gamma_n + \gamma_t + \gamma_{mn} + \gamma_{nt} + e_{nt}^{k} \tag{3.3}$$

I assume for simplicity that all the countries are small, and that the change in labour-tax rate in any country $n' \neq n$ will only affect the number of individuals locating in n through the migration between n' and n. On the other hand, changes in τ_{nt} will affect country n top earners' population through top earners' flows between country n and every other country n'. Therefore, the number of individuals locating in country n is a function of (1-τ_{nt}) and this relationship should be increasing in the top retention rate.

3.3.2 Identification Strategy

The conceptual framework of top earners' mobility summarized by Equation (3.2) shows that top taxpayers can move because of the level of taxes (τ_{nt}), before-tax wages (w_{nt}^{k}), various factors such as public goods, carrers opportunities or economical conditions loaded in Γ_{nt}^{k} and individual taste shocks (e_{nt}^{k}). The empirical question is how are top earners' location choices to one country affected by a change in the top income tax rate in this country. The simplest identification strategy exploits variations in top tax rates across countries and time (country-by-year variations) on top earners' mobility patterns. To properly identify the effects of taxation on location choices, it is necessary to control (1) for all variations in w_{nt}^{k} that could be correlated with τ_{nt}^{k} and (2) for all migration determinants included in Γ_{nt}^{k} , especially because variations in the level of top tax rates τ_{nt}^{k} are most of the time not random and may be correlated with unobserved factors loaded in Γ_{nt}^{k}.

As shown by Equation (3.2), migration not only depends on top retention rates individuals face in the country where they choose to locate, but also on the set of counterfactual earnings that they could receive in each country included in their choice set. These counterfactual earnings are never observable, and neither are the counterfactual average tax rates. Hence, estimated responses to taxation through mobility could load migration that is purely driven by counterfactual earnings, in particular if counterfactual wages are correlated with top retention rates. The richness of the individual characteristics reported in the EU-LFS allows me to precisely measure individuals' skills and characteristics. As in Kleven et al. (2013) and Akcigit et al. (2016), I fully control for wages by including a vector a_t^k of nonparametric controls for individuals' ability, the effect of which I allow to vary by country (by interacting a_t^k with country fixed effect). By controlling for the interaction between each destination country fixed effect and rich individual ability measures, my estimation absorbs variations across countries over time of abilities' prices that could drive top earners' mobility patterns and are correlated with taxes.

Equation (3.2) also shows that location choices are affected by a set of migration determinants loaded in Γ_{nt}^k and that could be correlated with τ_{nt}^k. I first address this challenge by using systematic controls for country-specific invariant characteristics through the inclusion of country fixed effects that fully account for the component γ_n of Γ_{nt}^k. Even though country fixed-effects differentiate-out all the permanent factors that can affect supply and demand of top earners at the member state level, the identification strategy could still be affected by time varying shifts. I thus complement the country fixed-effects specification with the systematic inclusion of year fixed-effects, that control for any year specific shocks γ_t that would be correlated with top earners' mobility patterns and top income tax rates changes. Regarding the preference for home or more generally migration costs, captured by the parameter γ_{mn} loaded in Γ_{nt}^k, the estimation will control for alternatively origin-destination dummies in the logg-odd ratio analysis and a home dummy in the conditional logit specification.

This leaves me with a last source of endogeneity that lies in country-specific shocks γ_{nt} correlated with tax changes and mobility patterns. For instance, a recessionary shock in one country could be correlated with a top income tax reform implemented in response to this shock, but also to simultaneous changes in top earners' mobility trends from and to this country due to the recession, and not to the top income tax reform. To address this issue, I follow Akcigit et al. (2016) and exploit the differences in propensity to be treated by changes in top tax rates across individuals. To do so, I allow the effects of top income tax rates on individuals' mobility to vary with individuals' earnings deciles. Individuals with high earnings levels are treated by top income tax rates, while individuals in lower income tax brackets are not affected by changes in top income tax rates. This approach is conceptually close to a difference-in-differences strategy where I compare location choices of individuals in the top tax bracket to individuals who do not face the top marginal tax rate, but are comparable in how their mobility patterns should be affected by unobserved simultaneous shocks. It enables to filter-out time-varying shocks γ_{nt} that affect similarly treated and control groups and that are correlated with location choices and top tax rates changes. For instance, this strategy will entirely control for the effects of a country-specific recessionary shock that affect mobility patterns' of the treated and the control group and is correlated with changes in tax rates in this country. The difference-in-differences strategy relies on the assumption that treated and control groups are affected similarly by unobserved country-specific shocks γ_{nt}. In the case where mobility patterns of top ten percent individuals are affected differently by unobserved country-specific time varying changes correlated with top income tax rates changes, this strategy does not allow to perfectly filter-out simultaneous cofounders.

3.4 Macro-Level Analysis of Top Earners' Migration Responses to Taxation

Equation (3.2) establishes that the number of top earners who choose to locate in country n at time t is affected by the top retention rate in this country $1 - \tau_{nt}$. I start the empirical investigation of this relationship at the macro-level and verify the prediction of the theoretical framework at two, successively more detailed levels.

3.4.1 Log-Odds Ratio Analysis

I start the macro analysis of migration flows and taxation by focusing on the migration condition derived in the theoretical framework through Equation (3.2). I follow Moretti and Wilson (2017) and use the model of top earners' mobility to relate differentials in top tax rates with top earners' aggregated migration flows between two countries. Making an assumption on the distribution of one of the utility parameters, it is possible to use Equation (3.2) to directly derive an estimating equation that I am then able to take to my data. I denote V_{nt}^k the systematic component of the utility derived from location in country n such that $U_{nt}^k = V_{nt}^k + e_{nt}^k$ with:

$$V_{nt}^k = \alpha \log(1-\tau_{nt}) + \alpha \log w_{nt}^k + \gamma_n + \gamma_t + \gamma_{mn} + \gamma_{nt} \tag{3.4}$$

As explained before, a change in the level of top income tax rate affects the probability that a top earner moves from country m to country n. The magnitude of the effect of the tax change depends on the number of marginal top earners in this country, and therefore on the distribution of the term e. If the idiosyncratic components follow an i.i.d Extreme Value Type I distribution, from MacFadden (1978):

$$Prob(U_{nt}^k > U_{n't}^k, \forall n \neq n') = \frac{exp(V_{nt}^k)}{\sum_{n' \in N} exp(V_{n't}^k)} \tag{3.5}$$

Equation (3.5) determines the number of top earners who choose to locate in each country in each period, and can under some assumption be estimated directly through a conditional logit from the individual-level data on location choices. With this model, the utility derived by moving from m to n is given by $U_{nt}^k - U_{mt}^k$. Using Equation (3.5) and denoting P_{mnt} the number of top earners who move from country m to country n at time t and P_{mmt} the number of top earners who choose to stay in country m, it is possible to write the log odds ratio as linear in the difference in utility levels in origin and destination country:

$$\begin{aligned} & log(P_{mnt}/P_{mmt}) \\ = \alpha[log(1-\tau_{nt}) - log(1-\tau_{mt})] + \alpha log(w_{nt}/w_{mt}) + [\gamma_n - \gamma_m] + [\gamma_{nt} - \gamma_{mt}] + \gamma_{mn} & \end{aligned} \tag{3.6}$$

Focusing on the utility of movers compared to stayers conveniently allows to differentiate-out the denominator of Equation (3.5) for the macro-level analysis.[16] The estimated parameter α captures the effects of top marginal tax rates differentials on top earners migration flows, and will therefore give a proxy of the elasticity of migration with respect to taxation in terms of *flows*.[17] I estimate Equation (3.6) (1) controlling for

[16] In the next section, I estimate Equation (3.5) with a full alternative-specific logit model and a maximum likelihood estimator. This allows me to consider *all* location choices for the estimation, and not to restrict the analysis to country-pair with non-zero migration flows, in addition for controlling for individuals' unobserved heterogeneties and thus unobserved counterfactual wages. In the micro-level estimation of location choices, the origin country enters in the estimation through a dummy for the origin country and the clustering of standard errors by country of origin and year. I discuss this point later in the analysis.

[17] Moretti and Wilson (2017) shows that the elasticity in terms of flows is equal to the estimated α scaled by 1-P where P is the

all origin-level and destination level time-invarying characteristics through origin-country fixed effects and destination-country fixed effects, (2) filtering all time-varying factors through year fixed effects, (3) partially controlling for country time-varying variables (GDP per capita and overall population) and (4) controlling for migration costs at the origin-destination level through origin-destination fixed effects in the preferred specification. I also follow Moretti and Wilson (2017) by allowing a two-way clustering of the standard errors at the country-pair and origin$\times$ year level. I present the estimated values of α across specifications in Table 3.2 while Figure 3.4 shows the binscatter plots for the specification that adjusts for country-pair fixed effects, year fixed effects and origin-year fixed effects. If top tax rates affect the migration decisions of top earners, the relationship between net-of-tax rates differentials and log odds ratio should be significant and positive. The plot and the associated estimates show that higher destination-origin net-of-tax retention rate differentials are systematically significantly associated with higher origin-to-destination migration, consistently with the prediction of the theoretical model. The coefficient on log personal top income tax is large and significant and ranges from 1.2(.60) to 2.1(1.0) across specifications. As my main estimation strategy exploits the differential effects of top tax rates on individuals with different propensities to be treated by these changes, I run a placebo check on the estimation using individuals in the bottom fifty percent that should never be treated by top tax rates. I show in Figure 3.5 that bilateral migration flows of individuals with lower earnings levels are not affected by changes in top tax rates.

3.4.2 Tax Reforms

I next turn to quasi-experimental evidence, exploiting exogenous changes in top income tax rates. Using a differences-in-differences approach, it allows to visually plot the effects of a change in the top marginal tax rates on mobility flows of individuals affected or not by the reform. Mainly, such country-level analysis exemplifies the type of variations that will be used in a more systematic way in the micro-level analysis, exploiting differences in propensity to be treated by top tax changes across individuals.

The reform consists in an increase of 5 percentage point in the French top MITR through the creation of a new top tax bracket on income earned in 2012.[18]. At the end of December 2011, an exceptional surtax of 4% on both capital and labour income for individuals with more than 250,000 euros had also been voted. This reform that applied to earnings of 2011 declared in 2012, should affect top earners' arrivals starting in 2012. Therefore, the response of top earners' flows observed in 2012 is a combination of the new bracket implementation and the announcement of the top earners' surtax. I use the **?**Abadie et al. (2010) method to build a control group for France. This approach has the advantage to use a similar population, top ten percent individuals in neighbouring European countries, but who were not affected by a change in the top marginal tax rate in 2012. Panel A of Figure 3.6 shows the difference-in-differences setting created by the reform, plotting immigration flows of top earners to France (treated) to synthetic France (control), before

weighted average of the log-odds ratio. As in Moretti and Wilson (2017), P is very small in my sample and the elasticity is therefore well approximated by α.

[18] As the French tax system is not a pay-as-you go system, there is sometimes a lag between the year where the reform is announced and implemented. In that case, the creation of the new tax bracket at a marginal tax rate of 45% has been anounced by the newly elected government Hollande in September 2012, and implemented in 2013 on income earned in 2012.

and after the large change in tax rates (vertical red line). While the migration flows were roughly following parallel trends before the change was implemented, they started to diverge in 2012. This suggests that the top marginal tax rate reform was not implemented in response to differential trends in top earners' immigration. The Figure shows a decrease in top earners' inflows after the implementation of the reform compared to top earners migration to the control country. Inflows of high income earners are permanently lower during 3 years following the tax change, compared to the control country. The graph shows that the number of foreign top eanrers came back to their pre-reform level in 2015. It is worth emphasizing that in 2015, the French government implemented new tax rebates for rich immigrants (régimes des impatriés). This means that the 2015 year is partially treated by change in top tax rates for some eligible foreign top earners, which potentially bias my estimates towards zero (as the measure of top income tax rates is not adjusted for preferential tax schemes as explained earlier). I report an elasticity from a 2SLS regression of the form $\log P_{nt} = e \log(1 - \tau_{nt}) + 1(i = T) + 1(t \geq t_0) + \varepsilon_{it}$, instrumented with $1(i = T) \times 1(t \geq t_0)$, where i is the country (the treatment country T or the control), t is the year, t0 is the year of the tax reform. Those estimates capture medium-term responses as I compare outcomes a few years before the reform to a few years after the reform. The implied elasticity of the number of top earners immigrants with respect to the net-of-tax rate is large and statistically significant at the one percent level, with a point estimate of 3.6(1.2).

Panel B of Figure 3.6 shows the same difference-in-differences setting now using bottom earners as a placebo group that should not be directly treated by the change in the top tax bracket rate. The Figure shows that the share of foreign bottom earners in France and in the control country evolved similarly before and after the change in top tax rates, with no change in trends at the time of the tax change. The implied (placebo) elasticity of bottom earners with respect to the net-of-tax rate in the top bracket is 1.1(1.2) and is not statistically different from zero.

3.5 Individual-Level Model of Mobility

As a significant part of the location choices are likely to be driven by unobserved heterogeneities across individuals, I turn to the full estimation of the individual location choice model described in Equation (3.2). This micro-level estimation presents two main advantages compared to the macro-level analys: it controls for individual-level determinants of migration and exploit differences in propensity to be treated by top income tax rates across individuals with different earnings levels leveraging all variations across all countries and years.

3.5.1 Specification and Estimation

To model the location choice of top earners, I adopt a multinomial discrete-choice model. From the theoretical model developed in Section 3.3, an individual k locating in country n at time t receives the utility:

$$U_{nt}^{k} = u\left((1 - \tau_{nt}) w_{nt}^{k}\right) + \Gamma_{nt}^{k} \tag{3.7}$$

For the empirical specification, I assume log utility of consumption, which allows me to rewrite utility as additively separable in pretax earnings and the tax rate. My benchmark estimation sample is a representative sample of all employees residing in 21 European countries for the period 2009-2015. I am able to observe the location choice and the earnings' decile of each individual for one period of time t. For each individual, I observe a large set of time-invariant characteristics (age, education level, field of education, family status, citizenship) and the residence country of the individual in $t-1$. An important part of the empirical analysis is to control in a detailed and flexible way for the person-country-specific term Γ_{nt}^{k}, the counterfactual before-tax wage w_{nt}^{k} and to exploit differences in treatment by τ_{nt} across individuals.

Controlling for individual-country preference term (Γ_{nt}^{k})

(a) The individual preference for living in any member state at time t is first assumed to depend on individual-level characteristics a_t^k. These include individuals' age, age squarred, marital status and gender dummies, a dummy for being born outside the European Union, and an indicator variable for having a managerial position. The effect of these individuals characteristics is allowed to vary by country (they are all interacted with country fixed effects).

(b) The person-country-specific term Γ_{nt}^{k} is also affected by country-level characteristics loaded in γ_n and γ_{nt}. In order to filter-out any time-invariant determinants of migration, the estimation includes country fixed effects. To control for time-varying country-specific factors that could be loaded in Γ_{nt}^{k}, I include in the estimation a control for GDP per capita and a country-specific linear time trend. In an alternative specification, I replace the country-specific linear time trend and the GDP per capita by country $\times$ year fixed effects.

(c) Location decisions may also be affected by individual k taste for country n, for instance through a preference for home if the considered country is individual's origin country. As the EU-LFS does not allow to observe individuals' exact country of birth, I use the information on previous residence to infer the preference of individual k for country n.[19] I include a dummy equal to one if the individual was previously a resident in country n. As emphasized by Kleven et al. (2013), controlling for past residence captures most of the home bias, compared to control for birth country or country where the first patent was filled as in Akcigit et al. (2016).[20]

[19] I use the information on past residence provided by the data in order to build an individual-specific taste for country n γ_n^k that I use for modelling the location decision of individual k at time t. This inferred individual-country specific taste is viewed as time-invariant because the discrete location choice model is only used to model mobility decisions at time t, without modelling past residence choices in previous periods. As emphasized by Akcigit et al. (2016), this model implies that for any two countries, none of which is the home country of the invidual, the utility from living in one of these countries does not depend on the other country. An alternative methodology would be to consider a dynamic location choice model with several periods as in Schmidheiny and Slotwinski (2018). However, this would require rich individual-specific information for the set of previous location choices, which are not sufficient in my data.

[20] Controlling for the home bias through a dummy for past residence has also been implemented by Kleven et al. (2013) as a robustness check for their main specification. The column (6) of Table 4 in Kleven et al. (2013) shows that controlling for past residence absorbs most of the home bias that is captured by a dummy equal to one for birth country in other specifications, and does not change the estimates.

Controlling for counterfactual wages (w_{nt}^k)

An important determinant of location decisions lies in the unobserved counterfactual wage w_{nt}^k. Controlling for differentials in wages across countries is especially important when considering a very heterogeneous area such as the European Union. In the case where the labour market is fully flexible, individuals' ability completely determines their potential wages in each country. Part of the wage variation is thus well absorbed by the aforementioned controls that allow to control for aggregated trends at the country-year level and heterogeneities across individual-level characteristics prices across countries. In addition, I include a dummy for having a tertiary level of education, that controls for a robust and exogeneous measure of individuals' ability. This quality proxy indicator is interacted with country fixed effects and therefore fully absorbs country-level wages differences at the top of the ability distribution. I also consider specifications where I interact the ability indicator with country fixed effects and year trends, to capture differential evolutions over time in the wage premium in different countries.

Differences in propensities to be treated by the top marginal tax rate (τ_{nt})

The empirical analysis finally allows for differentials effects of top personal income tax rates on individuals of different earnings levels. As explained in Section 3.2.2, I use the top marginal tax rate on income as my tax measure. My estimation strategy exploits differences in propensities to be treated by top marginal tax rates that come from differences in earnings deciles. The propensity to be affected by top marginal tax rate increases with the level of income, reaching its maximum at the top of the income distribution. I follow the approach of Akcigit et al. (2016) and I interact the log of the top retention rate interacted with indicator variables for the individuals' earnings decile at time t, denoted $D(k)$:

$$U_{nt}^k = \alpha_{D(k)} log(1 - \tau_{nt}) + \alpha log(w_{nt}^k) + \beta_n x_t^k + \gamma_n + \gamma_t + \gamma_n^k + \gamma_{nt} + e_{nt}^k \tag{3.8}$$

The utility coefficient $\alpha_{D(k)}$ determines mobility responses of individuals in decile $D(k)$ to the net-of-tax top retention rate. A positive $\alpha_{D(k)}$ implies that an increase in the top net-of-tax retention rate in a given country has a positive effect on the probability of an individual with earnings levels $D(k)$ locating in this country. I use the coefficient of the individuals not treated by changes in top marginal tax rates to account for the bias loaded in the estimated coefficients on log retention rate. As in every difference-in-differences settings, the assumption is that treated individuals and individuals in the control group g are affected similarly by confounders captured by $\alpha_{D(k)}$, but only the treated group is affected by the change in top marginal tax rates. The treated group refers to the top decile, where the expected propensity to be treated by top tax rates changes is the highest. The control group refers to a group with a lower propensity to be treated, but affected by similar country-year level policies. The coefficient on the log top retention rate α_g for the control group should only load the effects of the unobserved factors in the error term and correlated with variations in τ_{nt}. I follow Akcigit et al. (2016) and I compute the effect of the top marginal tax rate on the location choices of the top ten percent individuals as $\Delta\alpha_g = \alpha_{topdecile} - \alpha_g$. This allows to differentiate-out unobserved time-varying factors correlated with the changes in top marginal tax rates and location choices that affect the treated and control individuals in a similar way. As for a standard difference-in-differences approach, the choice of the control groups will affect the estimates. In my setting, the treatment by the top marginal tax rate is a continuous function of individuals' earnings, and individuals just below the top decile may be partially treated by the top marginal tax rate. Therefore, the choice of the control group needs to balance between comparability with individuals in the top decile, and non-zero treatment probability. To reflect this treatment-comparability trade-off in the choice of the control group, I will present and discuss the results for several definition of the control group: individuals in the 9th-8th decile, individuals in the 6th-7th decile, individual in the bottom fifty percent, individuals in the 8th decile and individuals in the median decile.

Estimation and Computation of Elasticities.

All the specifications of the random-utility model described in Equation (3.8) can be estimated as multinomial discrete choice model. Denoting P^k_{nt} the probability that individual k locates in country n at time t, and with $X^k_{nt}\gamma = \alpha log(w^k_{nt}) + \beta_n x^k_t + \gamma_n + \gamma_t + \gamma^k_n + \gamma_{nt}$, we can write:

$$P^k_{nt} = \frac{e^{\alpha_{D(k)}(1-\tau_{nt})} + X^k_{nt}\gamma}{\sum_{n'} e^{\alpha_{D(k)}(1-\tau_{n't})} + X^k_{n't}\gamma} \tag{3.9}$$

The maximum likelihood estimation allows to predict P^k_{nt} the probability that individual k locates in country n at time t, and this for all the countries $n \in N$ available in individual k choice set at time t. Following Kleven et al. (2013) and Akcigit et al. (2016), I use the estimates of $\alpha_{D(k)}$ and the individual-level predicted probabilities P^k_{nt} to compute individual-level elasticities of location with respect to the top net-of-tax rate such that:

$$\varepsilon^k_{nt} = \frac{dlogP^k_{nt}}{dlog(1-\tau_{nt})} = \alpha_{D(k)}(1 - P^k_{nt}) \tag{3.10}$$

Equation (3.10) allows to link the structural model based on the utility specification described in Equation (3.8) to the individual-level sufficient statistic ε^k_{nt}. This parameter captures how the probability that any individual k included in the sample of estimation locates in any country n changes when the net-of-tax rate in this country is changed. The individual elasticity is a function of the estimated mobility-parameter $\alpha_{D(k)}$ that varies with individual's earnings decile, and of the predicted probability that the individual locates in country n P^k_{nt}. Following Kleven et al. (2013), it is possible to compute country-level aggregated elasticities

$$\varepsilon_{nt} = \frac{\alpha_{D(k)} \sum_k P^k_{nt}(1 - P^k_{nt})}{\sum_k P^k_{nt}} \tag{3.11}$$

which is equivalent to compute $\alpha_{D(k)}(1 - \bar{P}_n)$ where $\bar{P}_n$ is the average probability weighted by P^k_{nt} to locate in country n over the period of estimation.[21] Globally, as summary statistics, one can define ε as the

[21] The proof has been derived in Kleven et al. (2013) and yields a formula close to the elasticity formula used in the aggregated location choice model of Moretti and Wilson (2017) discussed in Section 3.4. In the case where the labour market is characterized by

weighted average elasticities across all countries. It would be possible to follow Kleven et al. (2013) and Akcigit et al. (2016) and to report separately the elasticity of foreigners ε_n^f from the elasticity of domestics ε_n^d in country n. Denoting I_n^d the set of all natives from country n and I_n^f the set of non-native from country n the authors show that:

$$\begin{cases} \varepsilon_n^d = \dfrac{dlog(\sum_{k\in I_n^d} P_{nt}^k)}{dlog(1-\tau_{nt})} = \dfrac{\alpha_{C_{kt}} \sum_{k\in I_n^d} P_{n,t}^k(1-P_{nt}^k)}{\sum_{k\in I_n^d} P_{nt}^k} \\ \varepsilon_n^f = \dfrac{dlog(\sum_{k\in I_n^f} P_{nt}^k)}{dlog(1-\tau_{nt})} = \dfrac{\alpha_{C_{kt}} \sum_{k\in I_n^f} P_{n,t}^k(1-P_{nt}^k)}{\sum_{k\in I_n^f} P_{nt}^k} \end{cases} \tag{3.12}$$

My preferred reported elasticity is computed using the baseline relationship exposed in Equation (3.11) without distinguishing between foreign and domestic top earners.[22] I call this parameter the uniform elasticity, using the denomination of Kleven et al. (2013). This is the policy-relevant parameter that indicates the overall effect of top tax rates on location choices of all taxpayers, as emphasized by Agrawal and Foremny (2018). For comparability purposes with previous studies, I use Equation (3.12) and compute the elasticity of foreign top earners defining I_n^f as the set of foreign residents with respect to country n. This parameter will be high by definition, as it relates to a smaller tax base and to individuals who by definition have a lower idiosyncratic attachment for country n.[23]

3.5.2 Results

I start by estimating the multinomial discrete location choice with maximum likelihood on the entire sample of all European employees with earnings in the 1st, 5th, 8th and top decile over the period 2009-2015. The top panel of Table 3.3 shows the regression estimates of the multinomial discrete choice model for the estimation sample including all individuals in the 10th, 8th and 1st decile of earnings. The bottom panel of Table 3.3 presents the same results for the estimation sample including all individuals in the 10th, 5th and 1st decile of earnings. Because the conditional logit model duplicates each observation by the number of location alternatives, it is not possible to estimate the model on the entire population of employees surveyed (21 $\times$ 5,700,000). To show that the estimates are not changed by the choice of the benchmark estimation sample, I re-estimate the multinomial discrete location model on a randomly selected sample of the entire original sample including individuals in all earnings deciles described in Table 3.1 and show the results in Table 3.4.

I start by estimating the multinomial logit controlling for the home bias as described in Section 3.3.2 and including country fixed-effects that enable to control for time-invariant country characteristics that could be correlated with top taxation rates and top earners' migration choices.[24] This corresponds to column (1) of

rigidities, displacement and sorting effects can arise and may change the elasticity formula as discussed in the Appendix of Kleven et al. (2013).

[22]The reported elasticity in this paper is directly comparable to the uniform elasticity in the flexible demand model estimated in Kleven et al. (2013).

[23]Equation (3.12) shows how the elasticity parameter is scaled by the average probability that individuals locate in country n at time t. If the home bias is strong, the predicted probability that non-natives or individuals previously located elsewhere, locate in country n at time t will be low, and the foreign elasticity will be high. This point has been made before by Kleven et al. (2013) and Akcigit et al. (2016).

[24]As the alternative-specific logit filters out all the variables which are constant across alternatives destination, year fixed effects are automatically controlled for. Hence, any year-specific factor that could be correlated with top marginal tax rates and top earners'

Table 3.3 and Table 3.4. Below the estimates of the utility parameters $\alpha_D(K)$, I report the values and the standard errors of the uniform elasticity with respect to the net-of-tax rate following Equation (3.11). I also report the elasticity of foreigners computed following Equation (3.12) where I_{nf} is defined as the number of top earners residing outside country n.

To control for the counterfactual earnings w^k_{nt}, I add to the baseline specification rich controls for individuals' ability described previously and that are interacted with country fixed effects. This specification corresponds to column (2) of Table 3.3 and Table 3.4.

I finally partially control for country-year variations that are correlated with variations in top tax rates and changes in top earners' mobility patterns by including a year trend interacted with country fixed effects. This allows to capture part of the effect of unobserved country-specific shifts correlated with changes in net-of-tax rates and individuals' location choices. This would for instance control for differential evolutions over time in the quality of public goods in different countries that could affect location choices and could be correlated with top retention rate changes. This specification corresponds to column (3) of Table 3.3 and of Table 3.4. To verify the robustness of the estimates to the top tax rate measure, I reproduce the preferred specification of column (3) using the alternative measure of top marginal tax rate that includes employees and employers social security contribution rates. This corresponds to column (4) of Table 3.3.

The estimated utility coefficient on the top retention rate is large and significant for top ten percent individuals and this for all specifications. It is also very stable and confirms the robustness of the estimate of α_{top10} to the inclusion of additional controls and to changes in the benchmark estimation sample. The results show consistently that top earners' location choices are significantly affected by top marginal tax rates. The coefficient on log net-of-tax rate declines monotonically with income, capturing well differences in propensity to be treated across earnings levels. Across all specifications, the effects of the top retention rate on location choices is systematically large, positive and statistically significant for individuals in the top decile, and then decreases smoothly with the level of earnings deciles. Therefore, individuals in lower earnings decile exhibit low and non significant coefficient on the log retention rate as showed in Table 3.3 for the median and the bottom decile and in Table 3.4 for all individuals below the 7th decile. The utility coefficient on the log top retention rate for individuals just below the top decile (9th-8th decile) is positive and statistically significant in some specifications. This reflects that in my setting, treatment by the top marginal tax rate is a continuous function of income. As illustrated by Figure 3.2, the top marginal tax treatment threshold does not necessarily correspond to the top decile threshold. As a result, $\alpha_{9th-8th}$ loads a partial treatment effect of top marginal tax rates. The magnitude of the coefficient should however be lower, as the mass of individuals in the 9th-8th decile are treated with lesser intensity than individuals in the top decile. This is reinsuringly systematically confirmed by the coefficient estimates showed in Table 3.3 and Table 3.4. The 9th-8th deciles may thus give us a lower bound estimate for the computation of the elasticity.[25]

mobility patterns are filtered out.

[25] Another explanation for the partial treatment effect detected in the coefficient of 8th-9th decile could be that individuals' location choices are affected by anticipation of future treatment. This mechanism is ruled-out by the assumptions of the discrete choice model, but could still arise in practice.

Using the preferred specification and the benchmark estimation sample of Table 3.3, the estimated migration elasticites of top earners range from 0.15 using the 8th decile as the control group to 0.25 using the 5th decile as the control group, and are both significant at the one percent confidence level. Because the elasticities are computed by differentiating out the effects of time-varying confounders loaded in the placebo coefficient α_g, the estimates filter-out all country-year level changes that affect similarly the top decile and the control group g. In that respect, using individuals in the 8th decile as the control group is preferable because they will be more comparable to individuals in the top decile. At the same time and as discussed in Section 3.2.2, they could also be partially treated by top marginal tax rates changes, leading to underestimate the computed elasticity. By contrast, individuals in the median decile have a very low propensity to be treated by top marginal tax rates. In that case, the coefficient α_g allows us to get rid of country-year changes that affect the top and the median decile of earnings' in a similar way, but may not perfectly control for the effects of time-varying country-specific affecting solely individuals at the top of the income distribution. For this reason, I find it useful to propose an interval, rather than a pure point estimate, and to report the results for various definitions of the control group as in Akcigit et al. (2016). The elasticities estimates using the full distribution of earnings presented in Table 3.4 are similar, with an estimated elasticity of 0.13 using the 9th-8th deciles as the control group, 0.27 using the 6th-7th deciles as the control group, and 0.35 using the bottom fifty percent as the control group.

The magnitude of the elasticities are small, and in line with the literature on international migration responses to taxation, while being lower than estimates for within-country mobility.[26] Moretti and Wilson (2017) find an elasticity of 0.4 for top inventors within the U.S while Agrawal and Foremny (2018) preferred estimate is 0.8 for top earners within Spain.

I find that the value of the elasticity with respect to the net-of-tax rate computed for foreign residents is larger, and lies between 0.7 and 1.7. This elasticity is structurally higher as it relates to a much smaller tax base. The finding of a much higher elasticity for foreign residents is consistent with the literature on international migration elasticity. Kleven et al. (2013) find that depending on the specification the non natives elasticity of football players with respect to the net-of-tax rate is between 0.6 and 1.3. Akcigit et al. (2016) estimate that the non natives elasticity of top inventors with respect to the net-of-tax rate lies between 0.6 and 1.0. Kleven et al. (2014) finally find that the migration elasticity of foreigners eligible to a specific tax scheme is between 1.5 and 2 in Denmark. Because it indicates how the probability that top earners located abroad decide to locate in one country when this country changes its top tax rate, the foreign elasticity can be compared to the macro estimates presented in Section 3.4. The estimated top earners' migration elasticity in the macro-analysis was around between 0.7 when focusing on the country-by-year variations in top marginal tax rates model and 1.5 using the logg-odd ratio model. The estimates obtained with the multinomial logit specification are thus exactly bounded by the estimates of the aggregated analysis.

To get a sense of the magnitude of the effects and to extrapolate from the benchmark estimates presented in Table 3.3, the results imply that if the average country decreases its top tax rate by 10 percentage points

[26] For comparison, Kleven et al. (2013) estimate a uniform elasticity that is between 0.2 and 0.4 on average for football players. This corresponds to column (3) of Table A3 in Kleven et al. (2013) that relies on uniform migration elasticities and no sorting or displacement effects.

from a level of 60 percent, the number of top earners in this country would increase by roughly 2 percent. These effects are therefore small in magnitude, and indicate that while European top earners' location choices are significantly affected by top marginal tax rates as shown by the estimated utility parameters in Table 3.3 and Table 3.4, the overall magnitude of tax-driven migration responses is small. To investigate plausible country-level specificities in tax-driven migration responses of top earners, I use the benchmark estimates of Table 3.3 to compute country-level elasticities as described by Equation (3.11) and presented in Table 3.5. Interestingly, my model yields an upper bound for the foreign top earners' migration elasticity in Denmark of 1.7, that is very close to the reduced-form estimate of the quasi-experimental setting presented in Kleven et al. (2014) for the same country. The results in Table 3.5 show substantial heterogeneities in the estimated elasticities of the number of top earners' with respect to the net-of-tax rate across European countries. Some countries like Luxembourg, France and the United Kingdom are characterized by high elasticities compared to the European average. Other countries like Austria, Italy or Poland have relatively lower elasticities. Abstracting from any other margins of responses than migration, my model indicated that top earners' tax base of Germany is two times less elastic to changes in top marginal tax rates compared to the top earners' tax base in France or Luxembourg. These differences in country-level migration elasticities reflect heterogeneities in top earners' tax base composition across European countries. To investigate this mechanism, I conduct an heterogeneity analysis on individuals' location choices and show how characteristics like top earners' occupations are correlated with tax-driven migration and may thus partially explain differences in top earners' tax base elasticity to net-of-tax rates.

These differences across countries are likely to translate into differences in incentives to implement beggar-thy-neighbor policies. To formalize these differences, I use the estimates presented in Table 3.5 to quantify the effect of tax-driven migration on European governments' tax revenue. For simplicity, I assume that the only margin of responses of individuals to taxes is through migration (e.g there is no labour supply effect of taxes). Keeping the assumption that the top marginal tax rate τ_{nt} approximates the effective tax rates applied to top earners in country n at time t, I consider the effects of a change in the top tax rate on governments' tax revenue taking into account migration responses to taxation. For a given change in τ_{nt}, I define the *behavioural burden* of the tax reform as the share of mechanical change in tax revenue due to a tax change that is lost to migration responses to the tax change. I show in the Appendix C.2 that this behavioural burden is equal to:

$$\phi_n = \frac{\tau_n}{1-\tau_n}\varepsilon_n \tag{3.13}$$

where ε_n is the average elasticity with respect to the net-of-tax rate as computed in Equation (3.11).[27] The parameter ϕ proxies the side of the Laffer curve with $\phi = 1$ indicating maximization of the tax revenue collected in the top tax bracket by the government. As soon as $\phi < 1$, the simplistic model indicates that any

[27] The tax revenue collected from top earners' and the efficiency cost of tax reforms should conceptually be a function of the income weighted migration elasticity of top earners $\bar{\varepsilon_n}$. A discussion on optimal linear and non-linear tax rate in the presence of tax-driven migration and with more flexible social preferences is detailed in Muñoz (2019b). As the data does not allow to observe the joint distribution of wages and migration elasiticies, I use the unweighted migration elasticity ε_n to compute the efficiency cost of top tax reforms, which is equivalent to making the assumption that individuals' migration elasticities are evenly distributed across income levels within the top decile.

change in the current level of top marginal tax rate increases total tax revenue despite migration responses to taxes. I report in Table 3.6 the calibration of the formula in Equation (3.13) using the estimated cross-country elasticities presented in Table 3.5 and the average of top marginal tax rates over the period 2009-2015. The goal of the exercise is to quantify the revenue effect of an increase in the top tax rate given the estimated top earners' migration responses to taxes and abstracting from any other margin of responses. The left panel of Table 3.6 shows that given the current level of top tax rates in European countries and the estimated migration elasticities, a change in the top tax rate is always revenue-increasing. The estimated international migration elasticities of top earners with respect to the net-of-tax rate are not large enough to use tax-driven migration as an argument against higher top tax rates, a point that has also been made by Kleven et al. (2020). While top earners' tax-driven migration responses are not large enough to capture entirely the tax revenue effects of a top tax rate increase, they can however still have an effect on the acchievable level of redistribution and thus on poorest individuals' welfare even when migration elasticities are small (Muñoz (2019b)).

What are European countries' incentives to tax differently foreign residents? To investigate this question, I compute the efficiency cost of a reform of top tax rate that would be targeted on all top ten percent earners located outside country n. This would correspond to a foreign tax scheme targeted on rich immigrants, as in the Danish case studied by Kleven et al. (2014), but with much broader income eligibility requirements.[28] In that case, and assuming no sorting or displacement effects, the efficiency cost of the reform is only affected by the migration elasticity of foreigners. Assuming that top tax rates can only be targeted on foreigners, and using the estimated foreign elasitcities presented in Table 3.5, the right panel of Table 3.6 shows that it would be revenue-increasing for many European member states to set top tax rates targeted on foreigners way below their actual level of top tax rates. This sheds light on the fact that countries have incentives to lower the top tax rates for top earners located abroad in order to increase unilaterelly their tax base. If the decrease in the top tax rate is not targeted on foreigners, the migration effect cannot compensate the overall decrease in tax revenue caused by the decrease in top tax rate as shown in the left panel of Table 3.6.

Controlling for country-year fixed effects

I investigate the robustness of my benchmark estimates to replacing country-specific linear time trend by country $\times$ year fixed effects that filter out all country-specific time-varying factors in the estimation. In my setting, differentiating all country-year varying factors is challenging for two main reasons. The estimation first faces a *"curse of dimensionality"* because of the multiplication of country-level parameters included in the structural model, due to the important number of alternative location choices in the full-fledge multinomial model on the one hand, and to the very large number of individual observations on the other hand. The introduction of many non-linear variables through the inclusion of indicators dramatically increases the number of parameters and the computational burden of the estimation. It is not possible to solve the maximum likelihood when the specification with country-year fixed effects is estimated on the sample used in Table 3.3. The second challenge relates to the fact that the flow matrix is sparse, with sometimes few

[28] Kleven et al. (2014) establish that the foreign tax scheme in Denmark targets the top 1% of earners.

observations by cell considered (for instance at the origin $\times$ year $\times$ country $\times$ income decile level). The convergence of the likelihood function becomes very sensitive with the addition of many indicator variables. Selecting a random sample of the data increases the sparsity of the flow matrix and issues caused by the non-linearity and the convergence of the likelihood estimator.

To get around the issues related to the computational burden and the convergence of the estimator, I first limit the number of alternative countries considered in the estimation including country-year fixed effects. I select individuals with earnings in the 10th, 8th, 5th and 1st decile for 11 countries (half of my original sample) for which the number of missing cells at the country $\times$ year $\times$origin $\times$income decile level is minimum.[29] To ease the convergence and the estimation of the structural model, I further normalize the effect of the log retention rate on location choices of individuals in the first earnings decile to zero. As the results showed in Table 3.3 and Table 3.4 systematically and consistently indicated a weak and non-significant coefficient on log retention rate for individuals in the bottom decile, this normalization is not restrictive. I use this restricted estimation sample to show that the benchmark results showed in Table 3.3 are robust to the inclusion of country-year fixed effects instead of country-specific linear time trends. The first column of Table 3.7 repeats the preferred specification of Table 3.3 while column (2) replaces the interaction of country fixed effect and year trend with a country-year fixed effect, therefore filtering-out simultaneous country-year level variations. The estimated values of the mobility parameter $\alpha_{D(k)}$ is very close in magnitude to the estimates obtained in Table 3.3. The stability of the estimated $\alpha_{D(k)}$ between column (1) and column (2) of Table 3.7 shows that the specification controlling for country $\times$year linear trend already filters-out most of the time-varying factors and that the addition of country-year fixed effects does not significantly change the results compared to the country-by-year specification. This suggests that the preferred specification of Table 3.3 controlling for country-specific linear time trend should be robust to the inclusion of country-year fixed effects.

Effect of Top Earners' Characteristics on Migration Sensitivity to Top Tax Rates

To understand the underlying mechanisms driving top earners' tax-driven migration within Europe, I finally conduct an heterogeneity analysis by focusing on movers (Table C.2). To investigate plausible heterogeneity in sensitivity to taxes across occupations, I interact the log retention rate variable with dummies for occupations, and plot the interaction coefficients in Figure 3.7. Individuals working in more constrained occupations, such as civil servant, are less likely to choose their location according to the retention rate, in contrast with individuals working in banking and insurance. This suggests that individuals working in some segments of the labour market can drive the overall top earners' migration elasticity. This is consistent with the findings of Kleven (2014) that show that top earners working in sports and entertaintment react more to changes in top tax rates through migration. I also find that, consistent with the literature, single and young top earners' males are more likely to be sensitive to tax differentials in their location choices when they move. These heterogeneities in individuals' sensitivity to taxes may partially explain why coun-

[29] This leads me to select the following countries: Austria, Belgium, Switzerland, Germany, France, Italy, Luxembourg, Poland, Slovenia, Slovakia and Great Britain.

tries with different tax bases composition are affected differently by top earners' tax-driven migration, as discussed previously.

The significance of the interaction between some occupations and top tax rates in migration decisions could also suggest that part of the estimated migration responses to taxes is driven by firms' responses to taxes differentials. I thus investigate in Section 3.6 how firm-level characteristics affect top earners' location choices.

3.6 Additional Mechanisms and Robustness of the Estimates

In this section, I present additional mechanisms and results on top earners' location choices responses to top tax rates. In particular, I investigate the role of firm-level charcateristics on migration responses to taxes. I use administrative data merged with the French part of the EULFS to confirm mobility responses measurement used in the analysis. I finally investigate the robustness of my estimates to alternative specifications imputing foreign tax schemes eligibility and taking into account transitions from self-employment to employment.

The Role of Employment-level Characteristics in Top Earners' Location Choices

While the results show that top earners' location choices are affected by top income tax rates, they do not allow to say much about potential underlying mechanisms of tax-driven mobility. I then investigate the role played by employers and more generally employment on top earners' reaction to taxation differentials through mobility. Employers could contribute, or even initiate, the migration decision. For each implicit employee-employer match observed in my data, firms could internalize a part of the income tax burden faced by employee, when hiring or allocating workers across the borders. As a result, the estimated elasticity may be a mix of employee and employer responses.

In this section, I investigate two plausible channels through which employers could affect top earners' residence location response to taxation, which are size of the company where individuals work and the transition between jobs in the labor market.

It is likely that the type of companies for which individuals are working, in terms of size, activity abroad or industry, affects the way their employees may be able to react to taxation through mobility. In theory, individuals working in bigger firms could benefit from more opportunities to work abroad. I use the information on the size of the firm where the individual works and report in column (1)-(2) of Table 3.8 my benchmark specification adding an interaction term between the decile of income, the log retention rate, and a dummy equal to one if the employees works for a firm with more than 50 employees. Because of computational issues, I conduct the estimation on a randomly selected subsample of the full estimation sample used in the baseline results of the estimation. Results suggest that there is no significant effect of working in a firm of bigger size on top earners' migration sensitivity to income tax differentials.

Another channel through which labor market may affect top earners' migration is job transition. I exploit the fact that the data allows me to observe if individuals change their employer before and after migration.

A change in country of residence could either coincide with a change in employer-employee match, or employees could stay employed with the same initial employer. The effect of a job transition on tax-driven migration is ambiguous. On the one hand, keeping the employer-employee match constant could lower the sensitivity of location decisions to retention rates because it increases the attachment to a given a local labor market. On the other hand, firms could allocate their employees across borders internalizing taxation rates differentials, and in this case the interaction between a constant employer-employee match and the log retention rate in migration location decisions could be positive and significant. I report in column (2) of Table 3.8 the results from the benchmark estimation adding an interaction term between the decile of income, the log retention rate, and a dummy equal to one if the individual changed its employer compared to the previous period conditionally on being employed in the previous period. Column (3) repeats this specification replacing the indicator with a dummy equal to one if the individual has a new employer in year t while being either employed, self-employed or unemployed in the previous period. The coefficients on the interaction terms are non significant, suggesting that top earners who changed their employer between year t and $t-1$ were not more likely to take advantage of top tax rates differentials regarding their location decisions between year t and $t-1$.

Measurement Checks Using French Administrative Data

To provide evidence on the consistency of my EU-LFS-based measure of mobility and income, I use specific features of the French administrative data. The French Statistic Institute (INSEE) proceeds to a yearly matching between the French labor force survey (*F-LFS or enquête emploi*), the universe of tax declarations of French residents (*déclarations 2042*), and the universe of transfers received from social security organizations (family allowances, transfers), in a database known as the ERFS (*enquête sur les revenus fiscaux et sociaux*). The match between the F-LFS and the administrative tax files is only done for individuals who have been surveyed during the last quarter of the labour force survey (March).

INSEE matches the individual labor force survey files of the last quarter with the individual's French tax file.[30] Individuals who cannot be matched from the EU-LFS to the French administrative tax base are dropped from the ERFS. A succesful match means that an individual surveyed in the French part of the EU-LFS can be linked to a French tax statement. I show in Figure C.3 that the share of new residents measured in the last quarter of the EU-LFS and the ERFS is very close, indicating that almost all new residents surveyed in the last quarter of the EU-LFS have been linked to a French tax record. This shows that the EU-LFS measure of the resident population allows me to observe individuals who become French tax resident after their migration. In the case where my mobility measure would capture non-permanent migration flows, where new residents would not pay their taxes in France, there would be a discrepancy between the number of new residents observed in the ERFS and the last quarter of the EU-LFS, as these individuals would not be matched to income tax files and would therefore be dropped from the ERFS.

[30] The matching procedure used by INSEE is the following: each year, they have the exhaustive sample of individuals surveyed in the F-LFS, where the set of information includes individuals' exact address (the sampling of the French Labor survey is based on housing taxation files, which implies that INSEE detains the exhaustive information on individuals' address), their full names, and their family structure. The French tax system is not a pay as you go system: individuals surveyed during the last quarter of year t are matched with the tax file they file at year t+1, that determines the amount of taxes they have to pay on income earned during year t.

Accounting for Specific Foreign Tax Rules

A potential confounder of the analysis could be the existence of specific foreign tax rules and regimes that would not be captured by my baseline top tax measure. The eligibility rules for this type of regimes are very specific and depend on numerous unobserved variables that are not measureable in my data such as past residence history for a long period of time (up to ten years), total duration of stay, hiring conditions by firms, exact wages levels and jobs specificities. Fortunately, no tax schemes targeted on foreigners have been *implemented* during the estimation period with the exception of Italy, limiting the risk of country-year level shock correlated with top marginal tax rates and top earners' migration patterns, if any. The fact that some tax breaks for foreigners exist could still matter for the estimation. However, these schemes apply to either very specific people, or very high income, greatly limiting the risk of omission in the estimation based on the entire top ten percent sample.[31]

To check the sensitivity of the estimates to the existence of foreigners tax schemes, I re-estimate the specification of Table 3.7 taking into account the existence of preferential tax schemes available for foreigners. For countries where preferential tax schemes for foreigners exist during the estimation period, I make the assumption that all individuals located elsewhere would face the preferential rate τ_n^f in country n, regardless of the characteristics that determine their eligibility to the preferential rate.[32] I present the results in Table C.3. Estimates are stable to the inclusion of foreigners' tax schemes in the top tax measure. The results show that the coefficient on log retention rate is still large and significant for top earners and decreases monotonically with individuals' level of earnings. Interestingly, the imputation of such schemes indicate some treatment on lower income groups location decisions, that seem to be negatively affected by the variation in top income tax rate. This could be explained by the fact that in contrast with other reforms in top tax rates, the implementation of foreigners tax schemes is directly correlated with migration patterns, or economic shocks that may affect mobility patterns of the treated and control group. For instance, the implementation in Italy of the inbound scheme in 2010 aimed to target high skilled return migration flows after that the Great recession led a lot of Italians, especially young, to leave the country. Such recession is correlated with the implementation of the scheme but also with bottom earners migration patterns to and from Italy.

To conclude, the results are not changed by the assumption that all top earners located outside country n would be facing the preferential tax rate for foreigners when moving to this country. Regarding the available statistics on the total number of individuals claiming preferential tax schemes, and the very specific eligibility criteria for these regimes, this assumption seems however unrealistic.

[31] For instance, the numbers published by the French Tax Administration show that over the period 2009-2015 the number of new residents eligible to the preferential tax regime was on average 700 individuals per year. Similarly, the impatriates regime in Denmark studied in Kleven et al. (2014) applies to the top 1%, and not the entire top 10% as studied in my sample. The Italian inbound regime has also occupation, education, and previous residence in Italy requirements that limit greatly the amount of individuals that are likely affected by the regime in my sample.

[32] τ_n^f becomes the taxation rate faced by individuals who move to n, but also the counterfactual tax rate that individuals who stay in their home country $m \neq n$, or move to a different country than n, could have faced if they had decided to move to n.

Shifting from Self-Employment to Employment

Migration responses to taxation may be simultaneous to changes in individuals' occupation. To take a simple example, a top earner who is an employee of his own company in France may switch his status from employee to self-employed if he moves to Belgium (where capital income rates are very low) after a large increase in income taxation in France. In some cases, occupation transitions could be significantly correlated with top earners' location choices and changes in top marginal tax rates, and could therefore affect top earners' tax sensitivity in location decisions. I can only observe individuals who are employed at time t but I am able to observe if these individuals were unemployed, employed or self-employed in the previous period. I build an indicator equals to one if the was self-employed in $t-1$.[33] I reproduce the benchmark specification adding an interaction term between top net-of-tax rate, the income decile of the individual and a dummy equal to one if the individual changed was self-employed in the previous period. Results in Table C.4 show that the interaction term is not significant, indicating that there is no evidence that top earners who shift from self-employment to employment are more or less likely to significantly react to income taxation through migration.

3.7 Conclusion

In this paper, I study the effects of top personal income tax differentials on top earners' mobility in 21 European countries, a topic of central importance for the European public debate on tax policy. I use a novel individual mobility dataset built from the largest European survey (EU-LFS) combined with collected data on top marginal tax rates on income to track top earners' location choices within the European Union over the period 2009-2015. I exploit the differential effects of changes in top income tax rates on location choices of top earners and individuals with lower earnings levels within a given country and year.

I start by analyzing the effects of top tax rates differentials on top earners' migration flows at the aggregate level. I find that higher destination-origin net-of-tax rate differentials are associated with higher origin-to-destination migration of top earners, consistently with the prediction of an aggregated location choice model, which translates to an estimated top earners' migration flows elasticity of 1.5. Top tax rates differentials do not affect bilateral migration flows of individuals with lower earnings, in accordance to my main estimation strategy that exploits differences in the effects of top tax rates on the migration of individuals with different earnings levels.

I then estimate a full-fledge multinomial model of location choices that controls for individuals' heterogeneities and exploit differences in propensity to be treated by top tax changes along the income distribution. The specification is close to a differences-in-differences design, where top earners are the treated group, and individuals in lower deciles are used as control groups. This approach allows me to filter-out any unobserved country-year change that could be correlated with location choices of the treated and the control group and top tax reforms. I find that top earners' location choices are significantly affected by top marginal

[33] I focus on changes between employed and self employed because they are more likely to be initiated by the individual, while transitions from unemployment might be affected by various other factors.

tax rates, while bottom earners are not, and this result is consistent across all specifications. I estimate that the elasticity of the number of top earners with respect to the net-of-tax rate is significant at the one percent level and lies between 0.1 and 0.3, using respectively individuals in the 8th and the median decile as the control group. I find substantial heterogeneities in top earners' migration responses to taxes. The migration elasticity is especially high for foreigners with estimates that range between 0.7 and 1.7, both significant at the one percent level. I also find evidence of heterogeneities in tax-driven migration behaviours regarding occupations. Top ten percent employees working in finance are for instance more sensitive to top tax rates in a country compared to top earners working in the public administration.

Overall, this paper emphasizes the effects of labor taxation on top earners' mobility, and aims to stress the challenges related to a free mobility area that is characterized not only by a lack of fiscal cooperation, but also by large heterogeneities across countries. I show that when considering a broad definition of the top earners' population, high income earners' location choices are significantly affected by top marginal tax rates. The results of the literature on superstars' migration responses to taxes thus hold for a more general definition of the top earners' tax base. This finding is consistent with the fact that migration responses to taxation have been at the core of the public debate on top tax policy over the past years in Europe. While European top earners' location choices are significantly affected by top marginal tax rates, the magnitude of the effect on the total tax base is however relatively small. The results indicate that on average migration elasticities alone are not large enough to justify lower levels of top tax rates in Europe. This average result however masks large heterogeneities across countries. Member states differ widely in terms of the sensitivity of their top earners' tax base to changes in top income tax rates which may lead to very different incentives to implement beggar-thy-neighbour policies. Because migration elasticities are significantly different from zero, they impose a constraint on governments' ability to redistribute compared to a world where location choices' of taxpayers are not affected by tax policy, even when they are small. An interesting avenue for research would be to quantify the potential welfare gains and losses caused by the estimated mobility elasticities in contrast to a situation where redistribution is free from tax-driven migration constraints.

Alberto Abadie, Alexis Diamond, and Jens Hainmueller. Synthetic control methods for comparative case studies: Estimating the effect of california's tobacco control program. *Journal of the American Statistical Association*, 105(490):493–505, 2010.

David R. Agrawal and Dirk Foremny. Relocation of the rich: Migration in response to top tax rate changes from spanish reforms. *Review of Economics and Statistics*, 2018.

Ufuk Akcigit, Salomé Baslandze, and Stefanie Stantcheva. Taxation and the international mobility of inventors. *American Economic Review*, 106(10):2930–81, 2016.

Ufuk Akcigit, John Grigsby, Tom Nicholas, and Stefanie Stantcheva. Taxation and innovation in the 20th century. 2018. NBER Working Paper No. 24982.

Jon Bakija and Joel Slemrod. Do the rich flee from high state taxes? evidence from federal estate tax returns. 2004. NBER Working Paper No. 8158.

Mike Brewer, Emmanuel Saez, and Andrew Shephard. Means-testing and tax rates on earnings. *Dimensions of Tax Design: the mirrlees review*, 1, 2010.

Peter A Diamond. Optimal income taxation: an example with a u-shaped pattern of optimal marginal tax rates. *American Economic Review*, pages 83–95, 1998.

Peter Egger, Doina Radulescu, and Nora Strecker. Effective labor taxation and the international location of headquarters. *International Tax and Public Finance*, 20(4):631–652, 2013.

Jonathan Hamilton and Pierre Pestieau. Optimal income taxation and the ability distribution: Implications for migration equilibria. *International Tax and public finance*, 12(1):29–45, 2005.

Henrik Kleven, Camille Landais, Mathilde Muñoz, and Stefanie Stantcheva. Taxation and migration: Evidence and policy implications. *forthcoming in the Journal of Economic Perspectives*, 2020.

Henrik J. Kleven. How can scandinavians tax so much? *Journal of Economic Perspectives*, 28(4):77–98, 2014.

Henrik J. Kleven, Camille Landais, and Emmanuel Saez. Taxation and international migration of superstars: Evidence from the european football market. *American Economic Review*, 103(5):1892–1924, 2013.

Henrik J. Kleven, Camille Landais, Emmanuel Saez, and Esben A. Schultz. Migration and wage effects of taxing top earners: Evidence from the foreigners' tax scheme in denmark. *Quarterly Journal of Economics*, 129(1):333–378, 2014.

Etienne Lehmann, Laurent Simula, and Alain Trannoy. Tax me if you can! optimal nonlinear income tax between competing governments. *Quarterly Journal of Economics*, 129(4):1995–2030, 2014.

Thomas Liebig, Patrick A. Puhani, and Alfonso Sousa-Poza. Taxation and internal migration: Evidence from the swiss census using community-level variation in income tax rates. *Journal of Regional Science*, 47 (4):807–836, 2007.

Vilen Lipatov and Alfons Weichenrieder. Optimal income taxation with tax competition. 2010.

Daniel MacFadden. Modeling the choice of residential location. *Spatial Interaction Theory and Planning Models*, 1978.

James A. Mirrlees. Migration and optimal income taxes. *Journal of Public Economics*, 18(3):319–41, 1982.

Raven Molloy, Christopher Smith, and Abigail Wozniak. Internal migration in the united states. *Journal of Economic Perspectives*, 25(3):173–96, 2011.

Enrico Moretti and Daniel J. Wilson. The effect of state taxes on the geographical location of top earners: Evidence from star scientists. *American Economic Review*, 107(7):1858–1903, 2017.

Enrico Moretti and Daniel J. Wilson. Taxing billionaires: Estate taxes and the geographical location of the forbes 400. *Working Paper*, 2019.

Mathilde Muñoz. How much are the poor losing from tax competition: The welfare effects of fiscal dumping in europe. *Working Paper*, 2019b.

Gwenael Piaser. Labor mobility and income tax competition. *International taxation handbook: policy, practice, standards and regulation. CIMA Publishing, Oxford*, pages 73–94, 2007.

Kurt Schmidheiny and Michaela Slotwinski. Tax-induced mobility: Evidence from a foreigners' tax scheme in switzerland. *Journal of Public Economics*, 167:293–324, 2018.

Jesus Seade. On the shape of optimal tax schedule. 1977.

Stefanie Stantcheva. Understanding economic policies: What do people know and learn? *Harvard University Working Paper*, 2020.

Joseph E Stiglitz. Self-selection and pareto efficient taxation. *Journal of public economics*, 17(2):213–240, 1982.

John D. Wilson. Optimal income taxation and international personal mobility. *American Economic Review*, 82 (2):191–196, 1992.

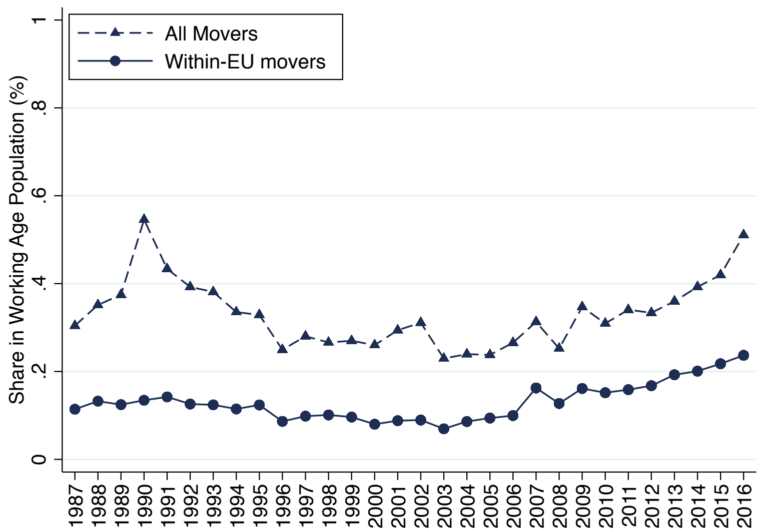
Cristobal Young and Charles Varner. Millionaire migration and state taxation of top incomes: Evidence from a natural experiment. *National Tax Journal*, 64(2):255–286, 2011.

Cristobal Young, Charles Varner, Ithai Z. Lurie, and Richard Prisinzano. Millionaire migration and taxation of the elite: Evidence from administrative data. *American Sociological Review*, 81(3):421–446, 2016.

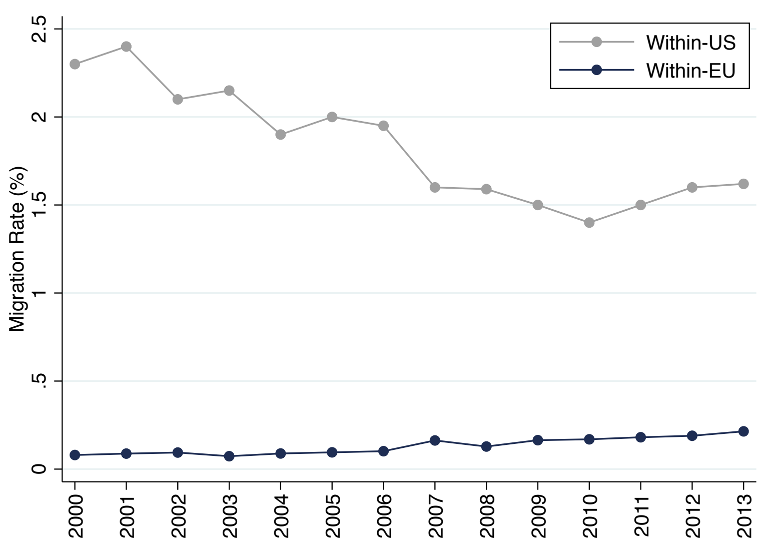
Figures

Figure 3.1: **Evolution of Mobility in the European Union**

Panel A. Within-EU Migration Rates

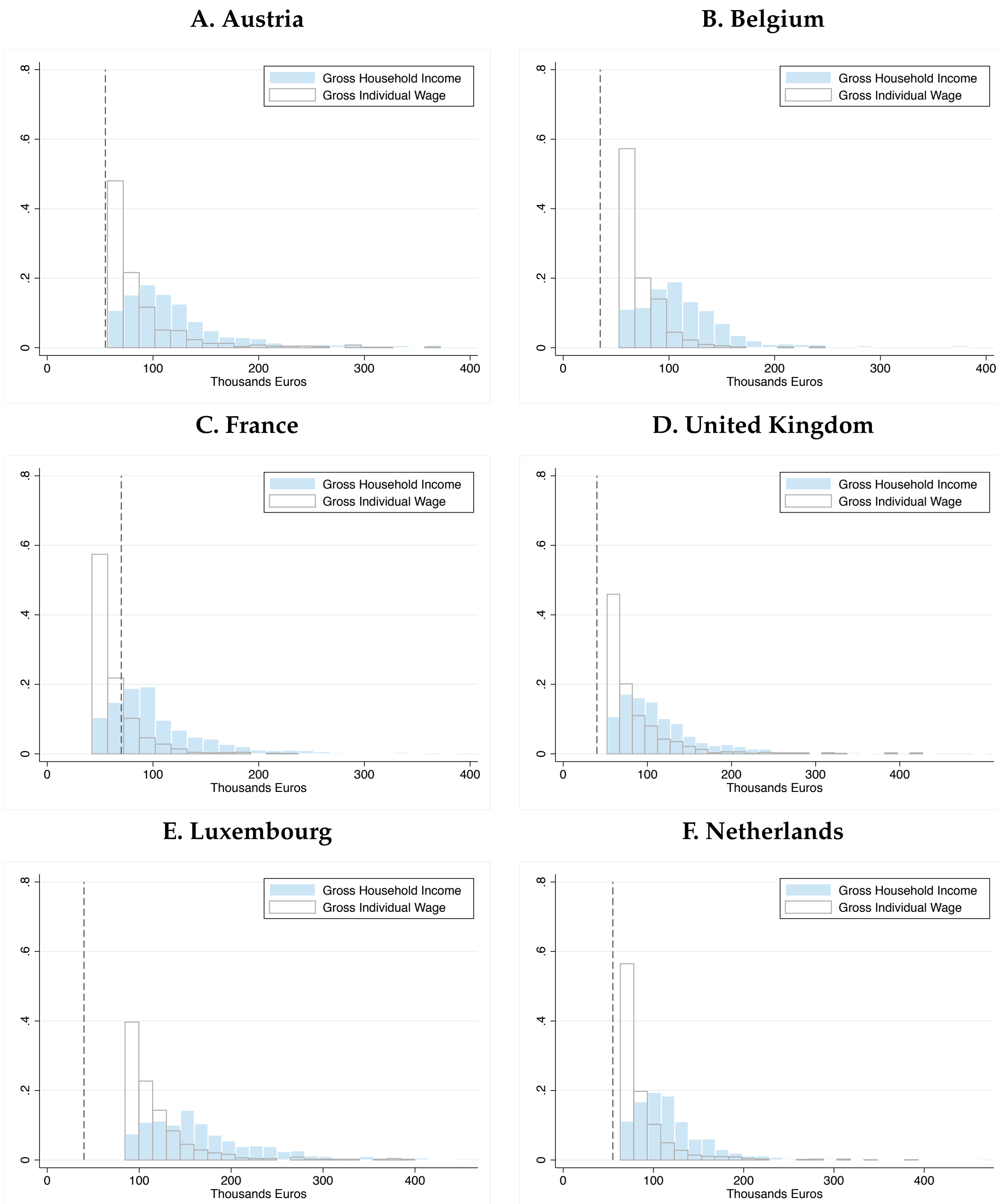


Panel B. Within-EU Versus Within-US Migration Rates



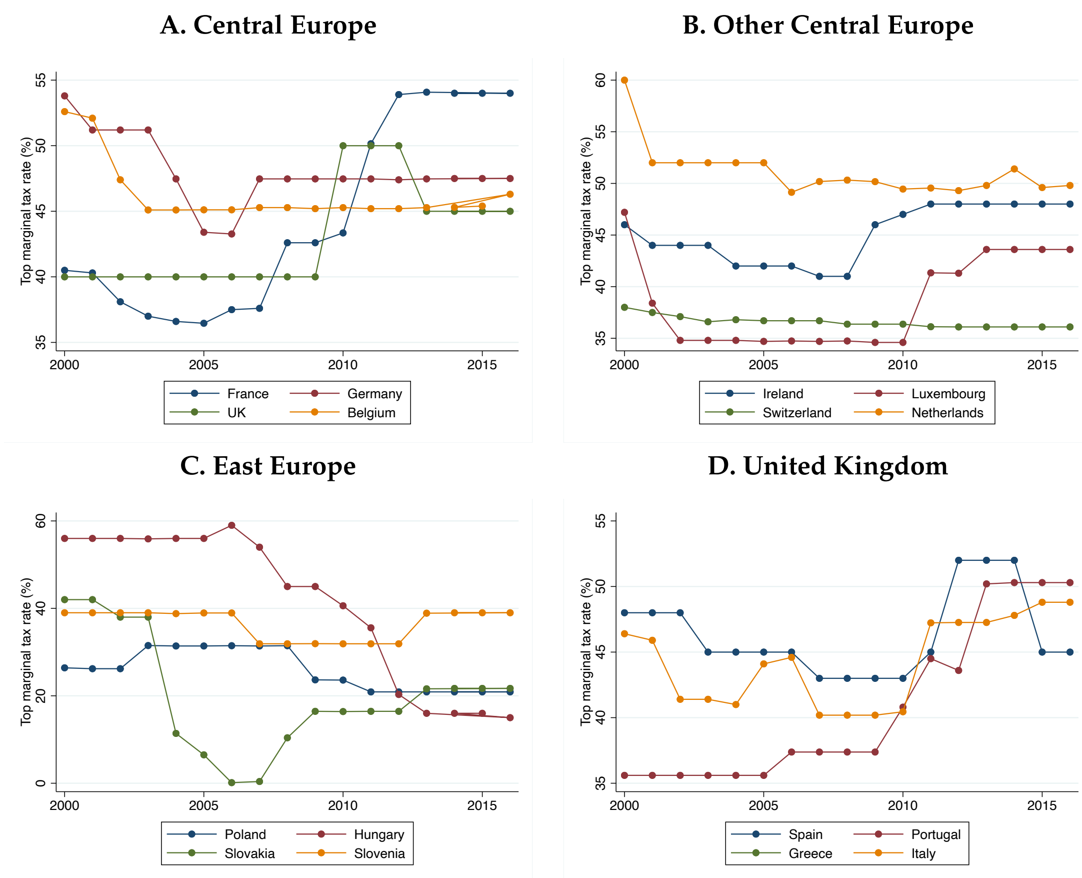
Notes: The Figure shows the evolution of working-age individuals' geographical mobility in the European Union since 1987. The definition of the European Union is dynamic and takes into account successive geographical enlargements. Geographical mobility rates are computed using the information on current and previous country of permanent residence of the EU-LFS, as described with more details in the text. The Figure plots within-EU mobility rate (share of EU working-age residents of year t who were residing in another EU member state in year t-1) and the overall mobility rate (share of EU working-age residents of year t who were residing in any other country in year t-1). Panel B compares the obtained serie for within-EU geographical mobility rates with within-US series for annual inter-state migration from Molloy et al. (2011).

Figure 3.2: **Top Decile and Top Marginal Tax Rate Threshold in 2009**



Notes: The Figure shows the distribution of individual-level main wage and household gross labour income in the top decile of the wage distribution in 2009. Data on individual wage and gross household income levels are from the EU-SILC. The top ten percent of the wage distribution in the EU-SILC is selected by ranking individuals on their main individual wage level, thus recreating the top ten percent of the income distribution used in the EU-LFS. Dashed lines represent the earnings threshold at which the top marginal tax rate on personal income applies (treatment threshold).

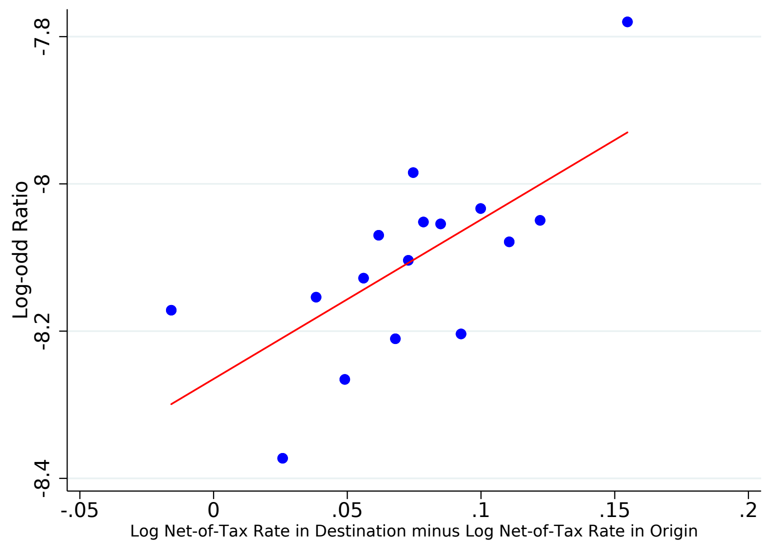
Figure 3.3: **Top Marginal Tax Rate Reforms in Europe**



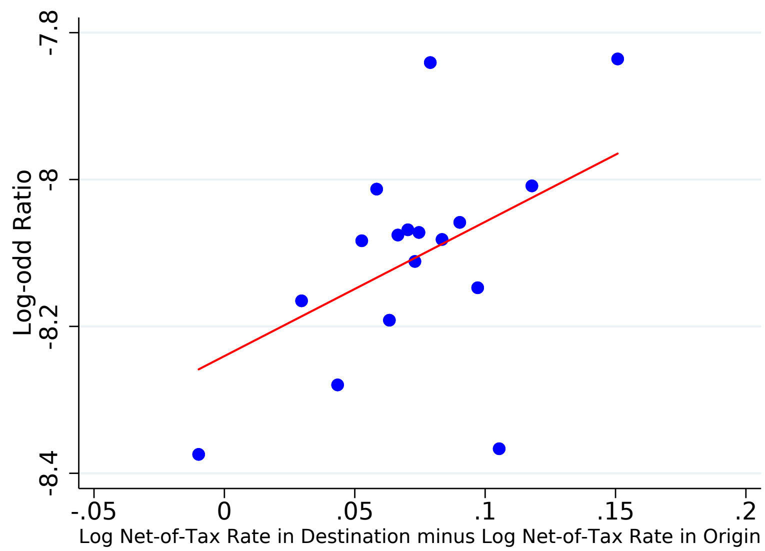
Notes: The Figure shows the evolution of top marginal tax rates in Europe since 2000.

Figure 3.4: **Effect of Top Tax Rates Differentials on Top Earners Bilateral Migration Flows**

Panel A. Baseline Specification



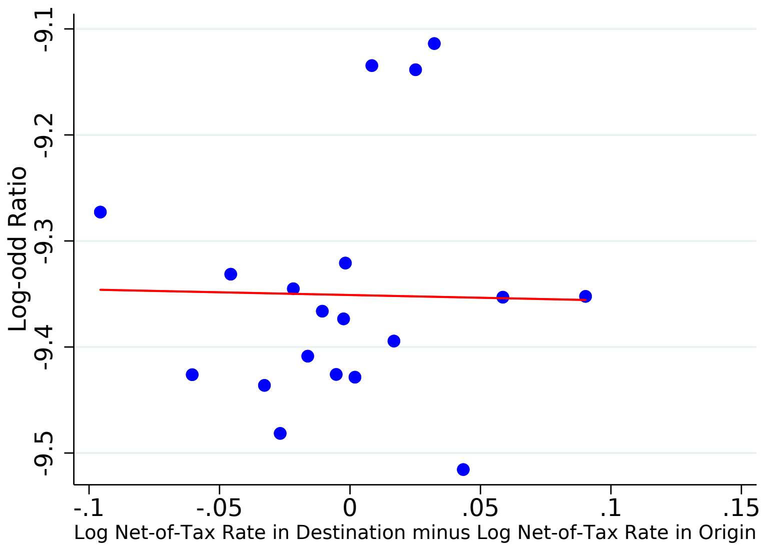
Panel B. Controls for Time-Varying Covariates



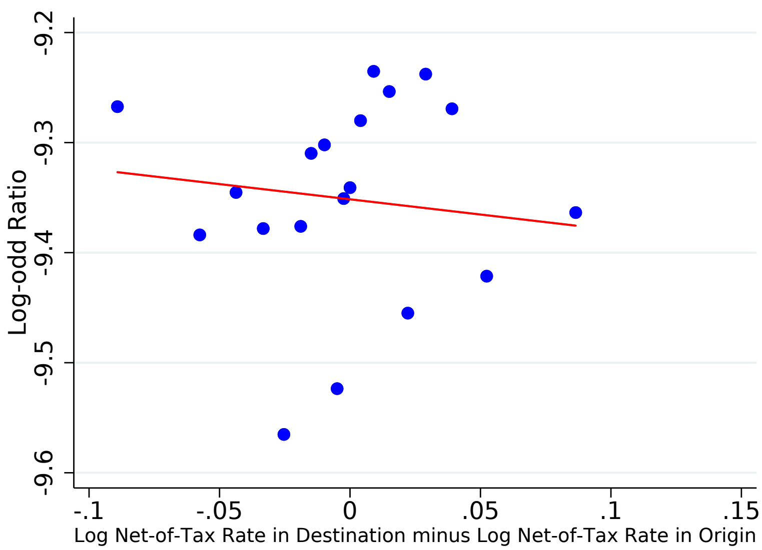
Notes: The Figure shows top earners' migration flows for a given origin-destination pair against the log top retention rate differential between destination and origin country over the period 2009-2015 for 21 European countries. The Figure plots within-bin averages using bins by 20 quintiles sorted on the measure of log retention rate used. Log-odds ratio are computed using $log(P_{mnt}/P_{mmt})$, where P_{mnt} is the share of individuals moving from country m to country n at time t. Measures of log retention rate and log odds ratio are demeaned of their country-pair, origin-year and year means corresponding of the specification presented in column (3) of Table 3.2.Panel B adds controls for country-year time-varying covariates as in column (4) of Table 3.2.

Figure 3.5: **Placebo Effect of Top Tax Rates Differentials on Bottom Fifty Bilateral Migration Flows**

Panel A. Baseline Specification



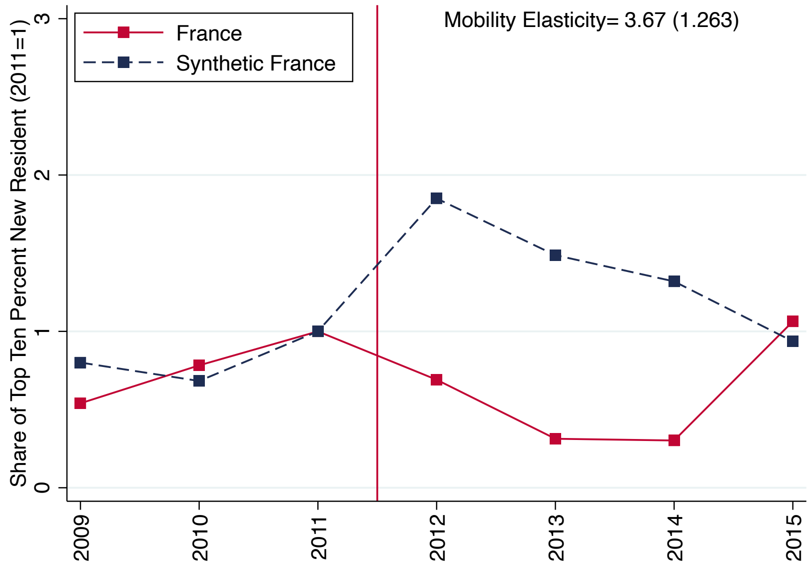
Panel B. Controls for Time-Varying Covariates



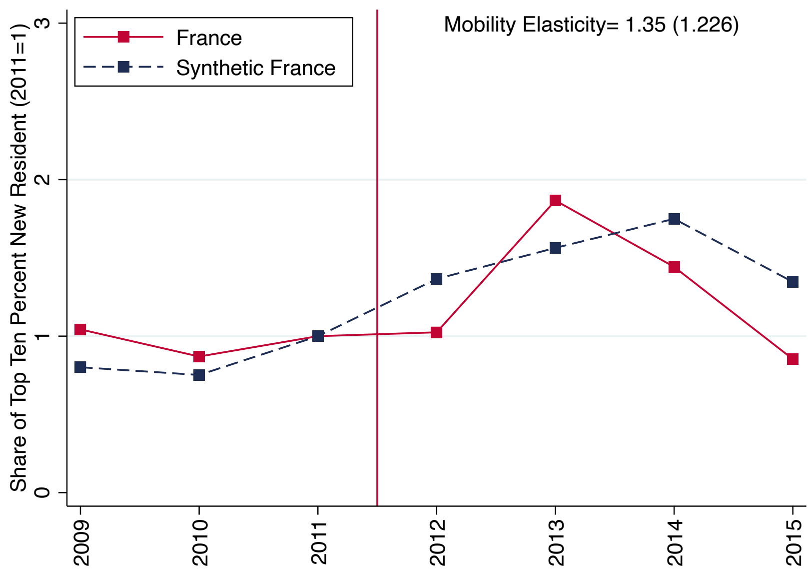
Notes: The Figure shows bottom earners' migration flows for a given origin-destination pair against the log retention rate differential between destination and origin country. Measures of log retention rate and log odds ratio are demeaned of their country-pair, origin-year and year means, repeating the specification of Figure 3.5.

Figure 3.6: **Migration Responses to Tax Increase in France**

A. Immigration of Top Ten Percent Earners

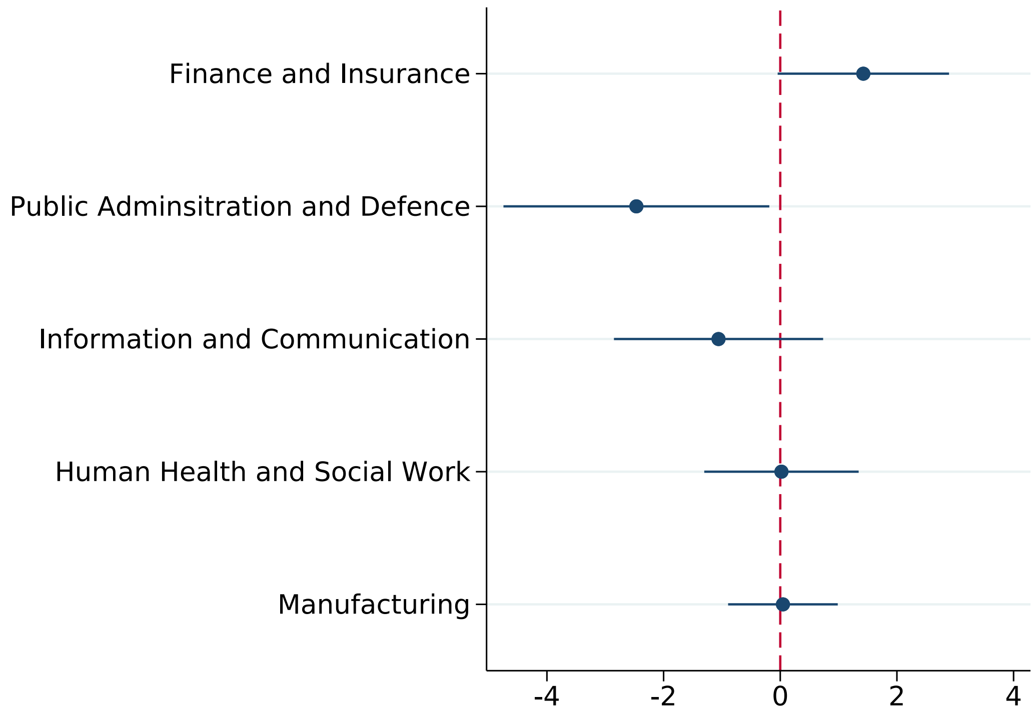


C. Immigration of Bottom Earners



Notes: The Figure shows immigration flows to France before and after a large increase in top marginal tax rate in the top bracket implemented in 2012, depicted by the vertical red line. The top panel compares immigration flows of top ten percent income earners to France and a synthetic control country build using the **?** method. The bottom panel repeats the same comaprison using immigration flows of bottom earners, not directly affected by the reform in the top tax bracket.

Figure 3.7: **Heterogeneity of Migration Responses to Taxation by Occupation**



Notes: This Figure shows the heterogeneity in top earners' location choices sensitivity to taxes by occupation. The graph plots the estimated coefficient of the interaction term between the log top retention rate with a dummy for working in finance, public adminsitration, information and communication, health or manufacturing, from the estimation presented in Table C.2. A positive and significant coefficient means that location choices of individuals working in this given sector are significantly more sensitive to taxes.

Table 3.1: **Descriptive Statistics for the Full Sample of Employees 2009-2015**

Variables	All Earnings Deciles	Top 10%
Number of observations	5,732,042	563,340
Age	40	44
Percentage of new residents	0.3%	.42%
Percentage of foreign born	12%	8.7%
Percentage of non-citizens	8%	4.7%
Percentage of non-citizens with an EU citizenship	3.7%	3.1%
Percentage with tertiary education level	48%	77%
Percentage of men	51%	74%
Percentage married	55%	70%
Percentage with managerial responsibilities	22%	57%
Percentage living in a densely populated area	44%	54%
Percentage working in a firm with more than 50 employees	45%	66%
Average number of hours worked per week	36	43

Notes: Descriptive statistics of the EU-LFS sample for the estimation period 2009-2015 for 21 European countries: Austria, Belgium, Switzerland, Czech Republic, Germany, Denmark, Estonia, Spain, Finland, France, Croatia, Hungary, Italy, Luxembourg, Latvia, Netherlands, Poland, Portugal, Slovenia, Slovakia and Great Britain. The sample is restricted to individuals whose age is between 18 and 62 years old, individuals surveyed who are employees and for which information on labour earnings decile is available, and to individuals with no missing information for previous country of residence (97% of the sample). Each individual observation is weighted by a coefficient that ensures the representability of the sample at the European level. Earnings deciles are attributed by Eurostat before the sample selection on age and information on previous country of residence. Information on country of birth is not available for German residents (surveyed in Germany) and the share of foreign born thus excludes Germany from the computation. When individuals have more than one citizenship, only the citizenship of their country of residence appears in the survey.

Table 3.2: **Effect of Top Income Tax Rates Differentials on Top Earners Migration Flows**

	(1)	(2)	(3)	(4)
$\log(1-\tau_{nt})/\log(1-\tau_{mt})$	1.21	1.4	2.1	1.8
s.e	(.60)	(.59)	(1.0)	(1.1)
Year FE	Yes	Yes	Yes	Yes
Origin FE	Yes	Yes	No	No
Destination FE	Yes	Yes	No	No
Covariates	Yes	Yes	No	Yes
Origin-Destination Controls	No	Yes	No	No
Origin-Destination FE	No	No	Yes	Yes
Origin FE $\times$ Year FE	No	No	Yes	Yes
Observations	435	435	435	435

Notes: Standard errors in parentheses are clustered at the origin-destination pair and origin $\times$ year level. This Table shows the estimates of Equation (3.6) and plotted in Figure 3.4. Country-year level covariates include log population and log GDP per capita.

Table 3.3: **Effect of Top Retention Rate on Top Earners' Location Choices**

	(1)	(2)	(3)	Alt. Tax (4)
	Control group: 8th decile			
log(1-τ)$\times$ top 10%	1.55	2.48	4.13	3.1
s.e	(.67)	(.70)	(1.1)	(.94)
log(1-τ)$\times$ 8th decile	1.2	1.26	3.0	2.71
s.e	(.61)	(.62)	(1.1)	(.91)
log(1-τ)$\times$ 1st decile	-.44	-.03	1.6	1.2
s.e	(.64)	(.64)	(.95)	(.95)
Uniform elasticity	.05	.16	.15	.11
s.e	(.04)	(.03)	(.04)	(.05)
Foreign elasticity	.14	.74	.67	.58
s.e	(.29)	(.25)	(.26)	(.31)
Observations	35,075,335	35,075,335	35,075,335	35,075,335
	Control group: 5th decile			
log(1-τ)$\times$ top 10%	.97	1.95	3.36	2.96
se	(.68)	(.70)	(1.0)	(.91)
log(1-τ)$\times$ 5th decile	-.26	.07	1.5	1.82
s.e	(.68)	(.63)	(1.0)	(1.0)
log(1-τ)$\times$ 1st decile	-1.04	-.41	1.04	1.18
se	(.67)	(.64)	(1.1)	(.94)
Uniform elasticity	.16	.25	.24	.17
s.e	(.04)	(.04)	(.04)	(.05)
Foreign elasticity	1.1	1.6	1.5	1.1
s.e	(.32)	(.36)	(.28)	(.27)
Observations	35,440,093	35,440,093	35,440,093	35,440,093
Country FE	Yes	Yes	Yes	Yes
Covariates $\times$ Country FE	No	Yes	Yes	Yes
Country FE $\times$ Year	No	No	Yes	Yes

Notes: Multinomial logit regressions with robust clustered standard error at the country of origin x year level in parentheses. Estimations are based on individual-level EU-LFS sample for the period 2009-2015. The sample estimation includes all individuals in the 1st, 8th and 10th decile of labour earnings for the top panel and all individuals in the 1st, 5th and 10th decile of labour earnings for the bottom panel. The data includes individuals located in Austria, Belgium, Switzerland, Czech Republic, Germany, Denmark, Estonia, Spain, Finland, France, Croatia, Hungary, Italy, Luxembourg, Latvia, Netherlands, Poland, Portugal, Slovenia, Slovakia and Great Britain. All specifications include country fixed-effects, and control for log GDP per capita. All specifications control for the individual-country variable which is a dummy equal to one if the country is the home country of the individual. Column (2)-(4) and (6)-(8) add the following individual-level covariates: age, age squared, gender dummy, marital status, a dummy for being born abroad, a dummy for having managerial responsibilities in the current job, and a dummy for having a tertiary level of education that controls for a structural measure of individuals' ability. All of these covariates are interacted with country fixed effects. Column (3)-(4) and (7)-(8) add a country-specific linear trend. The first row reports the coefficient on the log retention rate, interacted with a dummy for being in the top ten percent of labor earnings distribution. The second row reports the coefficient on the log retention rate interacted with a dummy for being in the 8th decile of labor earnings distribution. The third row reports the coefficient on the log retention rate interacted with a dummy for being in the median decile of labor earnings distribution. The fourth row reports the coefficient on the log retention rate interacted with a dummy for being in the bottom decile of the earnings distribution. Columns (4) and (8) include a measure of the top marginal tax rate on earnings combined with social security contributions rates. Foreign elasticity is the elasticity of top ten percent the number of foreigners with respect to the net-of-tax rate. The uniform elasticity is the elasticity of the total number of top ten percent individuals with respect to the net-of-tax rate. See text for more details on the computations and definitions of the sufficient statistics.

Table 3.4: **Full Distribution of Earnings**

	(1)	(2)	(3)
log(1-τ)$\times$ top 10%	1.91	3.37	3.14
s.e	(.60)	(.96)	(1.0)
log(1-τ)$\times$ 8th-9th decile	1.64	2.47	2.27
s.e	(.30)	(.78)	(.91)
log(1-τ)$\times$ 6th-7th decile	.87	1.59	1.28
s.e	(.32)	(.78)	(.92)
log(1-τ)$\times$ bottom 50	-.39	1.02	.76
s.e	(.45)	(.78)	(.923)
Country FE	Yes	Yes	Yes
Covariates + Country FE	No	Yes	Yes
Covariates + Country FE x Year	No	No	Yes
Control: 9th-8th decile			
Foreign elasticity	.23	.81	.78
s.e	(.55)	(.55)	(.55)
Uniform elasticity	.04	.14	.13
s.e	(.09)	(.09)	(.09)
Control: 6th-7th decile			
Foreign elasticity	.91	1.7	1.7
s.e	(.58)	(.60)	(.60)
Uniform elasticity	.16	.27	.27
s.e	(.09)	(.09)	(.09)
Control: bottom 50			
Foreign elasticity	2.0	2.1	2.1
s.e	(.66)	(1.1)	(1.2)
Uniform elasticity	.35	.35	0.35
s.e	(.11)	(.18)	(.17)
Observations	23,445,104	22,202,622	22,202,622

Notes: Multinomial logit regressions with robust clustered standard error at the country of origin x year level in parentheses. Estimations are based on random selection of the overall EU-LFS sample described in Table 2 for computation ease. The data includes top earners located in Austria, Belgium, Switzerland, Czech Republic, Germany, Denmark, Estonia, Spain, Finland, France, Croatia, Hungary, Italy, Luxembourg, Latvia, Netherlands, Poland, Portugal, Slovenia, Slovakia and Great Britain. All columns include a country fixed-effect and control for log GDP per capita. Individual-country variable includes a dummy equal to one if the country is the home country of the individual. Column (2) to (3) add the following individual-level covariates: age, age squared, gender dummy, marital status, a dummy for being born abroad, a dummy for having managerial responsibilities in the current job, and a dummy for having a tertiary level of education that controls for a structural measure of individuals' ability. All of these covariates are interacted with country fixed effects. Column (3) adds a country-specific linear trend. Elastiticies are computed with several definition of the control groups as detailed in the text.

Table 3.5: **Estimated Country-Level Elasticities**

	Foreign elasticity		Uniform elasticity	
	Lower bound	Upper bound	Lower bound	Upper bound
Austria	.723	1.72	.06	.09
Belgium	.695	1.67	.19	.27
Denmark	.721	1.72	.11	.14
France	.615	1.49	.32	.45
Germany	.635	1.52	.16	.24
Italy	.702	1.68	.05	.06
Luxembourg	.734	1.74	.26	.37
Netherlands	.721	1.72	.09	.15
Poland	.675	1.61	.12	.18
Portugal	.720	1.72	.10	.15
Spain	.696	1.66	.24	.34
Switzerland	.663	1.60	.29	.41
United Kingdom	.635	1.46	.51	.81
European average	.673	1.61	.17	.24

Notes: Estimated elasticities at the country level using utility parameters estimated from the preferred specification (column (3) and (7) of Table 3.3) and the formula of Equation (3.11) averaged over the period 2009-2015.

Table 3.6: **Efficiency Costs of Top Marginal Tax Reforms**

	Scenario 1 Efficiency cost of $\tau_{uniform}$ reform				Scenario 2 Efficiency cost of τ_f reform			
	Lower bound	dR/dT	Upper bound	dR/dT	Lower bound	dR/dT	Upper bound	
Austria	.06	≥ 0	.09	≥ 0	.70	≥ 0	1.6	≤ 0
Belgium	.15	≥ 0	.22	≥ 0	.57	≥ 0	1.38	≤ 0
Denmark	.13	≥ 0	.17	≥ 0	.91	≥ 0	2.2	≤ 0
France	.37	≥ 0	.52	≥ 0	.70	≥ 0	1.7	≤ 0
Germany	.14	≥ 0	.22	≥ 0	.57	≥ 0	1.4	≤ 0
Italy	.05	≥ 0	.07	≥ 0	.66	≥ 0	1.7	≤ 0
Luxembourg	.21	≥ 0	.28	≥ 0	.57	≥ 0	1.4	≤ 0
Netherlands	.09	≥ 0	.15	≥ 0	.72	≥ 0	1.7	≤ 0
Poland	.05	≥ 0	.07	≥ 0	.27	≥ 0	.7	≥ 0
Portugal	.10	≥ 0	.15	≥ 0	.72	≥ 0	1.7	≤ 0
Spain	.19	≥ 0	.27	≥ 0	.56	≥ 0	1.4	≤ 0
Switzerland	.16	≥ 0	.293	≥ 0	.37	≥ 0	.9	≥ 0
United Kingdom	.40	≥ 0	.65	≥ 0	.52	≥ 0	1.3	≤ 0

Notes: Calibration of Equation (3.13) using estimates from Table 3.5. The efficiency cost refers to the behavioural cost created by the reform divided by the mechanical change in tax revenue after the reform given the current level of top tax rates.

Table 3.7: **Robustness to Country×Year Fixed Effect**

	(1)	(2)	Alt. Tax (3)
log(1-τ)× top 10%	2.94	3.07	2.50
s.e	(.77)	(.76)	(.83)
log(1-τ)× 8th	2.22	2.31	2.03
s.e	(.56)	(.59)	(.60)
log(1-τ)× 5th decile	.680	.720	.815
s.e	(.61)	(.60)	(.61)
Country FE	Yes	Yes	Yes
Covariates × Country FE	Yes	Yes	Yes
Country FE × Year	Yes	No	No
Country FE × Year FE	No	Yes	Yes
Observations	12,366,900	12,366,900	12,366,900

Notes: Multinomial logit regressions with robust clustered standard error at the country of origin x year level in parentheses. Estimations are based on individual-level EU-LFS sample for the period 2009-2015. The sample estimation includes all individuals in the 1st, 5th, 8th and 10th decile of labour earnings. The data includes individuals located in Austria, Belgium, Switzerland, Germany, France, Italy, Luxembourg, Poland, Slovenia, Slovakia and Great Britain. All specifications include country fixed-effects, an individual-country variable which is a dummy equal to one if the country is the home country of the individual, and the following individual-level covariates: age, age squared, gender dummy, marital status, a dummy for being born abroad, a dummy for having managerial responsibilities in the current job, and a dummy for having a tertiary level of education. All of these covariates are interacted with country fixed effects. Column (1) adds a country-specific linear trend, while Column (2) includes country-year level fixed effects. More details in the text for the computation of the selected sample.

Table 3.8: **Effect of Employment Characteristics on Individuals' Location Decisions**

	(1)	(2)	(3)
log(1-τ)× top 10%	5.33	3.87	4.31
s.e	(1.904)	(1.51)	(1.52)
log(1-τ)× 5th decile	2.27	1.27	1.70
s.e	(1.62)	(1.45)	(1.44)
log(1-τ)× 1st decile	.903	.264	1.03
s.e	(1.73)	(1.52)	(1.43)
log(1-τ)× top 10%× big firm	-1.907		
s.e	(1.65)		
log(1-τ)× 5th decile× big firm	-1.50		
s.e	(1.40)		
log(1-τ)× 1st decile× big firm	-1.55		
s.e	(1.50)		
log(1-τ)× top 10%× job transition		3.82	-.049
s.e		(2.86)	(1.93)
log(1-τ)× 5th decile× job transition		3.48	.414
s.e		(2.53)	(.867)
log(1-τ)× 1st decile× job transition		2.23	-1.37
s.e		(2.83)	(.725)
Covariates + Country FE	Yes	Yes	Yes
Covariates + Country FE x Year	Yes	Yes	Yes
Observations	10,635,981	10,635,981	10,635,981
Transitions from unemployment/self-employment inactivity	-	No	Yes

Notes: Multinomial logit regressions with robust clustered standard error at the country of origin x year level in parentheses on a randomly selected subsample of the original sample for computation ease. This table presents the result from the specification used in Table 3.3 adding interaction terms between earnings decile and employement related indicators. Column (1) adds the interaction between a dummy variable equals to one if the individual is working in a firm with more than 50 employees and a dummy for being either in the 10th, 5th or 1st decile of earnings. Column (2) adds the interaction between a dummy equals to one if the individuals has a new employer the year of the survey conditional on having been employed the year before and a dummy for being either in the 10th, 5th or 1st decile. Column (3) adds the interaction between a dummy variable equals to one if the individual has a new employer unconditional on having been employed the year before.

Chapter 4

How Much Are the Poor Losing From Tax Competition? Welfare Effects of Tax Dumping in Europe

4.1 Introduction

Freedom of movement within the European Union is the cornerstone of union citizenship, and has been at the core of European integration since the Treaty of Rome in 1957. While free mobility of individuals between member states has now been effective for sixty years, tax coordination between European countries is still non-existent: member states set their tax rates at the national level, and the tax and transfers schedules remain outside the scope of the union policy.

In this paper, I explore the welfare consequences for European citizen of living in a symmetric free mobility union characterized by tax competition, rather than in a symmetric free mobility union with uniform taxation - a *federal union*. I start with a simple theoretical framework, where the free mobility union is composed by perfectly symmetric countries and where redistribution is fully consumed, that is to say making the (conservative) assumption that public spending does not produce anything else than immediate consumption for residents. In my model, the main difference between the competition and the federal union comes from tax-driven mobility. When countries are forced to set a uniform tax rate, individuals' location choices cannot be affected by differences in country-level taxes. By contrast, when countries engage in tax competition, individuals react to unilateral changes in taxation rates through migration. I start by deriving the optimal tax and transfer schedules when countries are competing and when countries are setting a uniform federal tax rate. I theoretically emphasize how mobility responses to taxation - *migration elasticities*- affect the redistributive ability of competing governments. The optimal tax formulas shed light on two main mechanisms that affect redistribution in the presence of tax-competition. Redistribution in the competition union is lowered because tax-driven migration reduces the amount of taxes that can be collected by the government, as individuals at the higher end of the income distribution respond to higher tax rates with emigration (*revenue-channel*). Redistribution in the competition union is also lower because higher rates of taxation increases the absolute number of transfer beneficiaries through mobility at the bottom of the income distribution, leading to a lower level of transfer per individual (*transfer channel*).

I then take the optimal tax formulas to the data, and quantify how individuals' welfare is changed between a tax competition union and a federal union, following my theoretical assumptions. I focus my analysis on the *distribution* of the welfare effects of tax competition across earnings levels. I show that individuals are differently affected by tax competition depending on their income level, and that the magnitude of the welfare effects of tax competition varies with the intensity of tax-driven mobility and the redistributive tastes of the government. I show that even when the elasticity of the number of taxpayers with respect to the net-of-tax rate is small (far below utility), following what has been estimated in the literature, the welfare costs of tax competition for poor individuals can be sizeable. My results show that the bottom fifty percent always loses from tax competition, and that being in a competition union rather than in a federal union decreases poorer individuals welfare up to -20 percent.

The main contribution of this paper is to consider the problem of tax competition from a welfare perspective. This paper thus is related to a vast literature on the optimal taxes and transfers schedule, starting with the seminal work of Mirrlees (1971), studying how behavioural responses to taxation affects the optimal tax policy of governments. My analysis relies on the sufficient statistics approach developed by Piketty (1997) and Saez (2001), and extensively summarized in Piketty and Saez (2013). The introduction of migration in the canonical model of optimal taxation dates back Mirrlees (1982), and has been generalized by the contribution of Lehmann et al. (2014) that shows how the shape of the optimal income tax schedule of a Rawlsian government is affected in the presence of migration. Compared to those papers, I derive the optimal tax rate in an open economy with linear and discrete tax brackets, and general welfare weights, that emphasize the two channels through with tax-induced mobility affects redistribution.

This paper also relates to many studies that focus on the theoretical incitations for governments to engage into tax competition (Keen and Konrad (2013), Blumkin et al. (2015), Tiebout (1956), Oates (1972), Oates (1999)) or how to enforce cooperation and coordination (Kanbur and Keen (1993)). My paper focuses on the welfare implications of tax competition for people by quantifying the effects of lower tax rates for individuals' consumption.

4.2 Linear Tax Schedule

I start the analysis with a simple linear tax framework, that considerably simplifies the derivation of the optimal tax formulas but allows to capture the equity-efficiency trade-off at the heart of the optimal taxation problem in the presence of migration. As we shall see later, the linear tax problem is closely related to the non-linear tax problem, and it is therefore useful to derive the optimal tax and transfer in the case of a linear tax instrument.

4.2.1 Individuals' Problem

I consider individuals who are heterogeneous with respect to their preferences and skills. I follow the approach of Piketty and Saez (2013), where individual i has an utility $u_i(c_i, y_i)$ that is increasing in consumption and decreasing in earnings, as earnings require labour supply. Individuals are heterogeneous with respect to their skills w_i that are continuously distributed in the economy. There is a mass N_i of type-i individuals who are characterized by the same preferences and skills $u_i(c_i, y_i)$. The total number of taxpayers in one country is given by $\sum_i N_i = N$, and the aggregated income denoted as $Y = \sum_i N_i y_i$. A type-i individual is endowed with skills w_i, and receives a pre-tax income y_i that is a combination of his exogeneous ability w_i and his amount of effort l_i, such that $y_i = l_i w_i$. The government observes pre-tax earnings, but the abilities of individuals are private information. The government sets a linear tax rate τ on observed earnings that is universally redistributed through a lump-sum transfer T_0, that can therefore be written as $\tau \times Y/N$. Individuals' budget constraint is therefore given by $c_i = (1-\tau)y_i + T_0$.

Labour Supply Decisions

Given their preferences and characteristics, individuals choose their labour supply at the intensive margin, which corresponds to their optimal amount of work l_i . Formally, they choose pre-tax earnings y_i that maximize $u_i(c_i = (1-\tau)y_i + T_0, y_i)$. Assuming no income effects, type-i individual utility $u_i(c_i, y_i)$ can be written as

$$u_i(c_i, y_i) = (1-\tau)y_i + T_0 - v_i(l_i) \tag{4.1}$$

The disutility from effort $v_i(l_i)$ is increasing and convex in effort l_i, and thereby in pre-tax earnings y_i. The individual-level optimality condition determines the earnings function $y_i(1-\tau)$, and the compensated labour supply elasticity captures the change in individual's earnings caused by a change in the net-of-tax rate $1-\tau$:

$$e_i = \frac{\partial y_i}{\partial(1-\tau)} \times \frac{1-\tau}{y_i} \tag{4.2}$$

The elasticity of earnings with respect to the net-of-tax rate e_i is structurally determined by individuals' preferences. When the tax system is linear, the individual chooses y_i that maximizes $y_i(1-\tau) + T_0 - v_i(y_i)$. The first order condition is simply given by $1-\tau = v_i'(y_i)$. The differentiation of the first order condition allows to link the definition of the elasticity of earnings e_i to the structure of individuals preferences such that $\frac{1-\tau}{y_i} \times \frac{\partial y_i}{\partial(1-\tau)} = \frac{v_i'(y_i)}{y_i v_i''(y_i)}$. By definition of the disutility of labour, the elasticity of gross earnings with respect to the net-of-tax rate is always positive.

Location Choices

In a free mobility union, individuals can move from one country to another. I assume that individuals make the decision to migrate conditionally on their labour supply decision. I start by considering two perfectly symmetric countries A and B that constitute the entire world economy. Agents have an idiosyncratic taste for residing in one country that is captured by the parameter θ_i^A for country A and $\theta_i^B$for country B. Migration is costly, and agents have to pay a migration cost m if they decide to migrate, meaning that m is equal to zero in the absence of migration. The utility of individuals residing in country A can therefore be written as $u_i^A = (1-\tau^A)y_i + T_0^A - v_i(l_i) + \theta_i^A - m$, and symmetrically in country B as $u_i^B = (1-\tau^B)y_i + T_0^B - v_i(l_i) + \theta_i^B - m$. Agents m

igrate from country A to country B if and only if they receive a higher utility in country B. Therefore, any agent residing in country A has to satisfy the following conditions:

$$u_i^A = (1-\tau^A)y_i + T_0^A - v_i(l_i) + \theta_i^A - m \tag{4.3}$$

$$u_i(c_i^A, y_i, \theta_i^A, m) \geq u_i(c_i^B, y_i, \theta_i^B, m) \tag{4.4}$$

Equation (4.3) and Equation (4.4) define together the mass of individuals in country A N_i^A in equilibrium. Equation (4.4) emphasizes how the taxation rate in country A affects location choices in this country, taking everything else as given. Migration decisions to country A are determined by the *overall tax liability* of individuals in this country, combining the amount of taxes paid $\tau^A y_i$ and transfers received T_0^A, by contrast to labour supply responses that are driven by marginal tax rates only in the absence of income effects. We can directly derive from Equation (4.4) that the density of individuals with type-i preferences who decide to locate in one country can be written as a function of the net-of-tax rate in this country such that $N_i^A(1-\tau^A)$ and $N_i^B(1-\tau^B)$[1]. The density of type-i individual in one country can be increasing or decreasing in the net-of-tax rate in this country depending on how type-i individual consumption is affected by the linear tax rate. Formally, the consumption of type-i individual $c_i = (1-\tau)y_i + T_0$ can be rewritten using the definition of T_0 as $c_i = y_i + \tau(Y/N - y_i)$. I follow Saez (2002) and define the *break-even point* as the income level y_i such that $y_i = Y/N$ and at which transfers net of taxes are equal to zero. For any i such that $y_i < Y/N$, consumption is a *decreasing* function of the net-of-tax rate $1-\tau$, and N_i is therefore decreasing in the net-of-tax rate. Symmetrically, for any individual with $y_i > Y/N$, consumption is increasing in the net-of-tax rate and N_i is also increasing in $1-\tau$. Migration responses to taxation can be fully summarized in terms of elasticity concepts, and I define the migration elasticity as the change in the number of residents in one country when the retention rate is increased in this country:

$$\varepsilon_i = \frac{\partial N_i}{\partial(1-\tau)} \times \frac{1-\tau}{N_i} \tag{4.5}$$

The sufficient statistic ε_i summarizes the migration response of type-i individual to a change in the overall tax and transfer schedule at the income level y_i through a change in $1-\tau$. The intuition is that any increase in τ is redistributed to everyone through the universal demogrant T_0. In the absence of income effects, there is no labour supply changes implied by this additional redistribution. In the presence of

[1] In the linear model, writting the density function with respect to the net-of-tax rate rather than the consumption level considerably ease the problem exposure without loss of generality.

tax-driven migration, this additional redistribution creates a behavioural response to taxation, even in the absence of income effects. As described by Equation (4.4) any unilateral change in the level of transfers in one country will affect location decisions through the implied change in utility differential. Therefore, the migration elasticity of type-i individuals ε_i captures the net effect of increasing the net-of-tax rate on location decisions, combining the effects of taxes and transfers on individuals' utility level. For individuals with $y_i < Y/N$, an increase in the net-of-tax rate $1-\tau$ leads to a net increase in consumption through transfers, by contrast to individuals with $y_i > Y/N$. These differential effects of $1-\tau$ on individuals' consumption and thus migration decisions enter in the model by being directly loaded in the sign of ε_i. An increase in the net-of-tax rate that translates to an increase in the level of transfer induces immigration of low income levels ($\varepsilon_i < 0$), and emigration of higher income individuals ($\varepsilon_i > 0$). Therefore, by contrast to the labour supply elasticity, the migration elasticity can either be positive or negative, depending on how individuals' earnings relate to the break-even point. If tax-driven response is exactly the same for all individuals, the migration elasticity will have the same value in absolute, but will be of opposite sign at each side of the break-even point. I show in the next section how the effects of tax-driven mobility on the number and the composition of tax payers separately affect the optimal tax rate set by the competing government.

In addition to taxation, location choices are of course also determined by the distribution of migration costs and idyosyncratic preferences. These parameters are taken as exogeneous to the tax policy, and are therefore not affected by changes in the net-of-tax rate.

4.2.2 Government Problem

The government sets the linear tax rate τ, and redistribute the collected revenue through a universal demogrant T_0. Summing individual earnings functions $y_i(1-\tau)$ over the total number N of taxpayers in the economy allows to obtain the aggregate earnings $Y = \sum_i N_i y_i$. Total income in the economy is thus determined by individual earnings and the number of taxpayers at each income level in the economy, that are both a function of $1-\tau$. It follows that the government budget constraint can be written as $R = Y(1-\tau)\tau$. This tax function sheds light on the effect of taxation on tax revenue. When the tax rate is equal to one, there is no incentives to work and the tax revenue is equal to zero. When the tax rate is equal to zero, aggregated earnings are maximized but cannot be redistributed. The guaranteed income level T_0 is determined in equilibrium by the total amount of tax revenue R and the linear tax rate set by the government.

Social Preferences

The government chooses the level of taxes τ in order to maximize a social welfare function. I follow the approach developped by Saez and Stantcheva (2016) and use the concept of *generalized social marginal welfare weights* where g_i measures how much the government values the marginal consumption of individual i. This formulation is conveniently very general, and the welfare weights are only defined up to a multiplicative constant as they measure only the relative value of consumption of individual i. Therefore, the government preferences for redistribution will be loaded in the weights g_i. The overall spectrum of possible preferences for redistribution, from low to infinite, will be loaded in the distribution of the weights g_i across earnings levels.

Tax Systems

I consider a free mobility union where symmetric countries can either compete or cooperate regarding the collection of their tax revenue. Symmetric countries are characterized by the same exogeneous distribution of skills and population size. Importantly, I start by assuming that there is no spillovers from integration, such that there is theoretically no differences between the autarky and the federal systems other than migration driven by exogeneous parameters such as migration costs and idiosyncratic preferences.

For simplicity, I assume that there is no mobility outside the free mobility union meaning that individuals only move within the free mobility union. In this model, I call a federal union a union where all countries are constrained to set the same linear tax rate. The governemnt sets a uniform tax rate τ^f that is paid by everyone regardless of its residence in A or in B. As countries are perfectly symmetric in every aspect (size, distribution of skills, preferences, distribution of residence-specific tastes and distribution of migration costs), it does not matter for the analysis if the revenue collected with the federal rate is redistributed at the union or the country level. Because countries are perfectly symmetric, the federal rate set at the country or the union-level are similar. Of course, this definition of the federal union is a simplification and rules out any considerations linked to the fact that individuals may want to sort themselves in different countries because they have different tastes for public goods, which in turn may affect their welfare.

Reconsidering Equation (4.4) in the case where country A and country B impose the same federal rate, the difference in utility levels can only be driven by migration costs or individuals' preferences. It follows that in the federal union, the mass of taxpayers in each country is exogeneous to the taxation rate, as any change in the federal rate τ^f translates to a symmetric change in utility levels in both country, keeping the migration condition summarized by Equation (4.4) unchanged. Without any additional assumptions, as there is no tax-driven migration in the federal union, the federal tax rate is equal to the optimal tax rate in autarky.[2] The only behavioural response to taxes in the federal union is captured by the labour supply responses to taxation.

Rather than being part of a federal union, countries can choose to compete within the free mobility union. Tax competition means that countries set their respective tax rates and redistribute transfers separately, while individuals can freely locate in each country within the free mobility union. With competing countries, location decisions are affected by the competing linear tax rate set in country A τ_A^c and in country B τ_B^c as emphasized by Equation (4.4). Because of the tax competition, the population of taxpayers in each country is no longer independent from the taxation rate. The optimal tax rate of the competing economy τ^c is therefore affected by two behavioural responses to taxation: the intensive margin through labour supply responses to taxation, and the extensive margin through migration responses to taxation. Note that as countries are

[2] This is because wages are exogeneously determined, and even in the federal economy where migration may occur between two countries due to non-tax factors, a change in the tax rate applied to everyone does not distort migration decisions and is therefore not internalized in the government's maximziation problem. As we will see later, the independance of the federal tax rate to migration is likely to be changed in the case of endogeneous wages.

perfectly symmetric, they will by definition set the same tax rate in the competition Nash equilibrium.

4.2.3 Optimal Linear Tax rates

In this section, I derive the optimal linear tax rate of the government in the two available systems: tax competition and federal union. I present the derivation of the optimal linear tax rates following the small tax deviation approach, but the formulas can also be derived by fully specifying the welfare maximization problem. The optimal linear tax rate is such that around the optimum no small reform can yield a welfare gain. The welfare gains from any tax deviation are quantified by weighting the money metric welfare gains or losses to each individual using these weights. Optimal Linear Tax rate of the Federal Government:

$$\tau^f = \frac{1-\bar{g}}{1+e-\bar{g}} \tag{4.6}$$

Where e denotes the income weighted average labour supply elasticity $e = \sum_i \frac{e_i N_i y_i}{Y}$ and $\bar{g}$ captures a weighted average of welfare weights $\bar{g} = \left(\sum_i N_i g_i y_i\right) . \left(\sum_i N_i\right) / \left(\sum_i N_i g_i . \sum_i N_i y_i\right)$. The proof is formally derived in the Appendix, and intuitively below. Optimal Linear Tax Rate of the Competing Government:

$$\tau^c = \frac{1-\bar{g}}{1-\bar{g}+e+\bar{\varepsilon}} \tag{4.7}$$

Where e denotes the income weighted average labour supply elasticity $e = \sum_i \frac{e_i N_i y_i}{Y}$, $\bar{\varepsilon}$ is a combination of the *income weighted* and *population weighted* average mobility elasticity such that $\bar{\varepsilon} = \sum_i \frac{\varepsilon_i N_i y_i}{Y} - \sum_i \frac{\varepsilon_i N_i}{N}$ and $\bar{g}$ captures a weighted average of welfare weights $\bar{g} = \left(\sum_i N_i g_i y_i\right) . \left(\sum_i N_i\right) / \left(\sum_i N_i g_i . \sum_i N_i y_i\right)$, The proof is formally derived in the Appendix, and intuitively below. To derive the optimal tax rate in the presence of welfare weights, I consider an infra-marginal deviation in the tax rate $d\tau$ with no other effect on individuals' welfare than the effect on post-tax earnings. This is because of the classical envelop theorem argument, that implies that the change in individuals' labour supply after a small change in the tax rate does not change individuals' utility through disutility of work, as the optimal labour supply has been chosen at the optimum. The argument is the same for migration decisions. The welfare effect of the small tax deviation is therefore limited to its effects on post-tax earnings. The first effect of $d\tau$ on individuals' welfare is given by the increase in taxes paid by everyone $-\sum_i N_i g_i y_i d\tau$. The second effect on welfare is created by the change in transfers $\sum_i N_i g_i dT_0$. When N is exogeneous to the tax reform, the change in the universal demogrant is $dT_0 = dR/N$. In the case of a federal government, we can normalize the total population $N = \sum_i N_i$ to one without loss in generality, and use $dR = dT_0$. What is the effect of the small tax deviation on dR? The small tax reform creates a mechanical increase in tax revenue $d\tau Y$. As pre-tax earnings are endogeneously determined by the labour-leisure trade-off, $d\tau$ causes an additional change in pre-tax earnings because of behavioural responses to taxation. Using the definition of the labour supply elasticity, the change in tax revenue due to labour supply responses is $-\sum_i \frac{\tau}{1-\tau} N_i y_i e_i d\tau$. I rewrite this effect $-e\frac{\tau}{1-\tau} Y d\tau$ where $e = \sum_i \frac{N_i y_i e_i}{Y}$ is the income weighted labour supply elasticity. The total effect of the small tax change on tax revenue is therefore $dR = Yd\tau(1 - e\frac{\tau}{1-\tau})$. Using the expression for dR derived before, and the fact that at the optimum the net welfare effect of $d\tau$ is zero gives $\sum_i N_i g_i y_i d\tau = \sum_i N_i g_i (1 - e\frac{\tau}{1-\tau})Yd\tau$, which is equivalent to $1 - e\frac{\tau}{1-\tau} = \bar{g}$ with $\bar{g} = (\sum_i N_i g_i y_i) . (\sum_i N_i) / (\sum_i N_i g_i . \sum_i N_i y_i)$, that is a simple discretization of the standard formula $\bar{g} = \left(\int_i g_i y_i\right) / \left(\int_i N_i g_i . \int_i N_i y_i\right)$ with population normalized to one developed in Piketty and Saez (2013) and Saez and Stantcheva (2016).

When countries are competing, the total number of taxpayers becomes endogeneous to the tax system. The small tax deviation creates two behavioural responses to taxation: individuals respond to the tax reform through labour supply changes and migration decisions. The envelop theorem holds for location choices. Because the tax deviation considered is small enough, there is no effect on individuals' welfare through the change in migration decisions implied by $d\tau$. How is welfare changed in the presence of tax-driven migration by the small tax reform? Similarly than in the federal case, the welfare effect can be decomposed between the additional taxes paid for everyone in the economy and the change in the universal demogrant dT_0.

By contrast to the analysis in the federal union, in the presence of tax competition, the total mass of individuals in the economy cannot be normalized to one without making the restrictive assumption that migration decisions change the composition of the population keeping the total number of taxpayers constant. In the competing union, tax-driven migration modifies the amount of transfers received by residents *(i)* by changing the amount of taxes that can be collected and *(ii)* by changing the number of transfer beneficiaries among which the tax revenue is split. I show formally in the Appendix D.1.1 and Appendix D.1.2 how the *revenue-maximizing rate* differs from the *transfer-maximizing rate* because of this *transfer channel* that changes the absolute number of individuals who share the government revenue. Below, I develop the same intuition by using the small tax deviation approach.

How is the amount that can be redistributed among residents changed by the small tax reform $d\tau$ in the competing union? Using the definition of the migration elasticity, the change in the mass of type-i taxpayers after a small tax deviation is given by $-\sum_i \frac{N_i}{1-\tau}\varepsilon_i d\tau$, where ε_i is allowed to be positive or negative. This migration response of type-i individuals generates a change in taxes collected equal to $-\sum_i \frac{N_i}{1-\tau}\varepsilon_i d\tau \times y_i \times \tau$, as individuals come or leave with their overall tax liability $y_i\tau$. This term captures the *revenue effect* of tax-driven migration. In the presence of tax competition, any change in the linear tax rate changes the amount collected by the government because of the gais (or losses) of tax liabilities through mobility. The amount of revenue that can be redistributed to individuals in the economy is also changed by the absolute number of beneficiaries that is endogeneously affected by the reform. When the number of taxpayers is changed by $d\tau$, the reform generates a fiscal gain through the change in the absolute number of transfers' beneficiaries $\sum_i \frac{N_i}{1-\tau}\varepsilon_i d\tau \times T_0$. Note that for individuals below the break-even point, this term is negative ($\varepsilon_i < 0$) and captures the additional redistribution cost of bottom earners who move to the country where the transfer is increased. The overall effect of tax-driven migration on the amount that can be redistributed to everyone remaining in the country is therefore given by $-\left(\sum_i \frac{\tau}{1-\tau}\varepsilon_i N_i y_i d\tau - \sum_i \frac{\tau}{1-\tau}\frac{N_i}{N}\varepsilon_i Y d\tau\right)$. Summing this to the mechanical change in tax revenue of residents $Yd\tau$ and the labour supply effect $\sum_i \frac{N_i}{1-\tau}e_i d\tau \times y_i \times \tau$

gives the total change in the amount that can be redistributed to the total mass residents $d\tau \times Y \times (1 - \frac{\tau}{1-\tau}\sum_i \frac{e_i N_i y_i}{Y} - \frac{\tau}{1-\tau}\sum_i \frac{\varepsilon_i N_i y_i}{Y} + \frac{\tau}{1-\tau}\sum_i \frac{\varepsilon_i N_i}{N})$ and each individual remaining in the economy has a change in transfer received equal to $\frac{1}{N} \times d\tau \times Y \times (1 - \frac{\tau}{1-\tau}\sum_i \frac{e_i N_i y_i}{Y} - \frac{\tau}{1-\tau}\sum_i \frac{\varepsilon_i N_i y_i}{Y} + \frac{\tau}{1-\tau}\sum_i \frac{\varepsilon_i N_i}{N})$. Denoting $\varepsilon = \sum_i \frac{\varepsilon_i N_i y_i}{Y}$ the income-weighted average migration elasticity, $e = \sum_i \frac{e_i N_i y_i}{Y}$ the income-weighted labour supply elasticity and $\varepsilon_p = \sum_i \frac{\varepsilon_i N_i}{N}$ the population-weighted average migration elasticity, the transfer maximizing rate is such that $\frac{1}{N} \times d\tau \times Y \times (1 - \frac{\tau}{1-\tau}e - \frac{\tau}{1-\tau}\varepsilon + \frac{\tau}{1-\tau}\varepsilon_p) = 0$, which is equivalent to $\frac{\tau}{1-\tau} = \frac{1}{e+\bar{\varepsilon}}$where $\bar{\varepsilon} = \varepsilon - \varepsilon_p$ is a combination of the income-weighted and population-weighted average mobility elasticity. I discuss in the next paragraph the underlying mechanisms captured by this aggregated mobility parameter.

Let's finally consider the welfare maximizing linear tax rate such that the welfare gain of $d\tau$ is zero. How should we compute the welfare effect of $d\tau$ in the competing union? I discuss in details in the AppendixD.1.3 the normative challenges related to welfare aggregation, and definition, in an union with migration, because of the endogeneous size of the population. I derive as a baseline specification the welfare maximizing linear rate as the linear tax rate that maximizes the welfare of residents. The formal derivation of the optimal linear tax rate is presented in the Appendix D.1.3, and can also be derived using the small perturbation approach. The small tax deviation generates a loss in welfare for individuals remaining in the country after the reform due to the increase in taxes paid equal to $\sum_i N_i y_i g_i d\tau$, and a change in welfare due to the change in transfers received equal to $\sum_i N_i g_i \frac{1}{N} \times d\tau \times Y \times (1 - \frac{\tau}{1-\tau}\sum_i \frac{e_i N_i y_i}{Y} - \frac{\tau}{1-\tau}\sum_i \frac{\varepsilon_i N_i y_i}{Y} + \frac{\tau}{1-\tau}\sum_i \frac{\varepsilon_i N_i}{N})$. The total welfare effect of the small tax deviation is therefore $\sum_i N_i g_i d\tau \times Y \times \frac{1}{N} \times (1 - \frac{\tau}{1-\tau}\sum_i \frac{e_i N_i y_i}{Y} - \frac{\tau}{1-\tau}\sum_i \frac{\varepsilon_i N_i y_i}{Y} + \frac{\tau}{1-\tau}\sum_i \frac{\varepsilon_i N_i}{N}) - \sum_i N_i g_i y_i d\tau$. Summing the two welfare effects to zero yields the optimal linear tax tax formula with welfare weights described in 4.2.3 and derived formally in the the Equation (D.4) of the Appendix section D.1.3. Importantly, the averaged welfare weight $\bar{g} = (\sum_i N_i g_i y_i) . (\sum_i N_i) / (\sum_i N_i g_i . \sum_i N_i y_i)$ depends of the densities of residents N_i that are taken as given for the aggregation of welfare.[3]

The optimal linear rate of the competing union is a function of the mobility parameter $\bar{\varepsilon}$ that is a combination of the income-weighted and population-weighted mobility parameter. Note that the case where the *absolute* number of taxpayers is unchanged, $\sum \varepsilon_i \frac{Ni}{N} = 0$ and we are back to case where the optimal tax rate is only a function of the income-weighted mobility elasticity. In this specific case, the revenue-maximizing rate is equivalent to the transfer-maximizing rate, as in the classical federal case. In the general case, the effect of tax-driven mobility can now be decomposed between two terms. The first term captures the effect of migration on the tax revenue, through the *income weighted mobility parameter* $\varepsilon = \sum_i \varepsilon_i \frac{Niy_i}{Y}$.

[3] I discuss in the Appendix D.1.3 the normative challenges related to the aggregation of welfare in the open economy, explained by the fact that in the open economy, the total welfare can theoretically be increased by (i) increasing the consumption of individuals in this country but also by (ii) increasing the number of individuals who enter in the sum of individuals' welfare. To avoid any considerations due to population size other than its effects on the amount of transfers that can be redistributed, I consider a government that maximizes the welfare of a given population, taking into account the effect of tax-driven mobility responses on the consumption of this population. Typically, this welfare function would correspond to a government that would maximize the welfare of non-movers, taking into account the effects of movers on non-movers consumption through the amount of redistribution that can be achieved. I discuss this assumption in the Appendix, and derive in Equation (D.6) how the linear tax rate would be changed if one would to relax this assumption.

The second term captures the effect of tax-driven mobility on the absolute number of taxpayers through the *population-weighted mobility parameter* $\varepsilon_p = \sum_i \varepsilon_i \frac{Ni}{N}$. The net effect of migration on the optimal linear tax rate is therefore summarized by $\bar{\varepsilon} = \varepsilon - \varepsilon_p$. The first term captures the *revenue channel* that is to say the change in tax revenue collected caused by mobility responses to taxation. The second term captures the *transfer channel*, that is to say the change in the number of transfer beneficiaries caused by tax-driven mobility. The net effect of type-i individuals' mobility on the universal demogrant thus depends of the importance of their relative income compared to their relative weight in the population. Said differently, the government weights the mobility response of type-i individual by taking the difference between type-i individuals' fiscal gain and cost.

To illustrate the implications of the weighting of the migration elasticity ε_i, I discuss the implications of two extreme assumptions on the distribution of the mobility parameter ε_i. Let's first make the assumption that only bottom earners react to taxation through migration. This could be the case if, for instance, top earners have a very strong attachement to their national labour market, and do not react to taxation through migration, while bottom earners can easily move across borders. For bottom earners, consumption is an increasing function of the linear tax rate τ, and a decreasing function of the net-of-tax rate. Therefore, the stock of bottom earners N_b is a *decreasing* function of the net-of-tax rate, and it follows that ε_b is negative. What would be the optimal linear tax rate of the government in the case where tax-driven mobility is exclusively coming from bottom earners that would change their location decisions if transfers are increased? With mobility responses concentrated at the bottom of the distribution, as earnings of bottom earners are close to zero, the uniform mobility parameter is $\bar{\varepsilon} = -\frac{\varepsilon_b N_b}{N}$. As ε_b is negative, the uniform mobility parameter $\bar{\varepsilon}$ is positive and the resulting optimal linear tax rate in competition is lowered by tax-driven migration coming from the bottom of the distribution. What happens in the opposite situation, when tax-driven mobility only comes from the very top of the income distribution? This assumption could be verified if bottom earners have very strong migration costs while rich people can easily change their residence country. At the top of the income distribution, consumption is a decreasing function of the linear tax rate, and thus a decreasing function of the net-of-tax rate. Top earners' mobility elasticity ε_t is thus always positive. When the country considered is large enough, the population weight of very high earners becomes negligible, and the uniform mobility parameter entering in the optimal tax formula can thus be approximated by $\bar{\varepsilon} = \varepsilon_t N_t y_t / Y$ that is always positive. The main take away from these two examples is that no matter towards what side of the earnings distribution ε_i is skewed, the resulting optimal linear tax rate in competition is always lowered by tax-driven migration, leading to less redistribution in the competition union compared to the federal union. The mechanisms leading to less redistribution in these two extreme cases are different, and both emphasize the trade-offs faced by governments competing in a free mobility union with no cooperation. In the case where only bottom earners move in response to tax changes, the optimal amount of redistribution is exclusively lowered by the *transfer channel* of tax-driven mobility, that is to say the additional immigration of individuals who benefit in net of the tax and transfer system after an increase in the taxation rate. In the case where mobility responses to taxes are only coming from the top of the income distribution, the optimal amount of redistribution is exclusively limited by the *revenue channel* of tax-driven mobility, that is to say the amount of tax collected that is lost because of the emigration response to the increase in the tax rate.

4.2.4 The Welfare Effects of Tax Competition

I now turn to the quantification of the welfare effects of tax competition. For this purpose, I use the theoretical formulas derived in the previous section to quantify the welfare of individuals in the two available tax systems: tax competition and federal union. As described before, individuals derive an utility $u_i(c_i, y_i)$ that is decreasing with earnings due to disutility for work, and increasing in consumption. The welfare effect of tax competition compared to the federal union will be given by the change in individuals' utility from one system to another. This change in tax system will affect individuals' utility through three channels.

The choice of tax system will first affect individuals' pre and post tax earnings. The optimal tax rates set in each of the two systems differ because of the migration parameter, leading to different amount of taxes paid for a given level of income. In addition, due to labour supply responses to taxation, the differences in tax rates between the two systems will also lead to differences in individuals' pre-tax income.

Second, the change in labour supply induced by the change in tax systems will affect individuals' welfare through disutility for work.

Third, the choice of tax system will affect the amount of transfers received by individuals. The choice of tax system will affect pre-tax aggregated income that can be taxed by the governement, because of the changes in individuals' labour supply decisions. The choice of tax system will also affect the amount of transfers received by individuals through the change in the rate at wich the aggregated pre-tax earnings can be taxed in order to be redistributed to everyone.

Importantly, as I start by considering two *perfectly symmetric* competing countries, the competition tax rates set in equilibrium are perfectly similar. In this case, the density of tax-payers in each tax bracket is supposely unchanged, because the neighbouring country exactly mimic the other country tax policy. The competing tax rates are thus similar in the symmetric equilibrium. This implies that in the symmetric equilibrium, there are no welfare costs of tax competition through the change in taxpayers densities, transfers beneficiaries or migrations costs. The only difference with the federal union is the change in the optimal linear tax rates, as government take into account the fact that individuals can react to taxation through migration, without anticipating the tax rate set by the competing country, as in a very crude illustration of a Nash equilibirum. The computed welfare costs therefore correspond to the welfare effects of tax competition through the *migration threat*. Even if there is ultimately no tax-driven migration in the symmetric equilibrium, the welfare is changed through the change in the tax and transfer schedule implied by tax competition, and the fact that government internalizes individuals' migration threat. The symmetric equilibrium analysis is therefore very useful to estimate a *lower bound* for the welfare effects of tax competition, and to emphasize how competition affects individuals' welfare only through the incentives given to the government to lower its tax rate because of the competition. I will investigate the welfare effects of tax competition in an asymmetric equilibrium with endogeneously changed densities in the future.

Methodology

There are three key factors that determine the optimal linear tax and transfer schedules, and that are necessary to implement welfare calibrations: the behavioural labour supply and migration elasticities, the redistributive tastes of the government, and individuals' underlying preferences that determine the behavioural elasticities.

To quantify the welfare effect of the choice of tax system, it is necessary to make some functional form assumptions regarding the primitives of the model, that is to say individuals' utility functions. I start with a standard quasi-linear utility function with no income effects

$$u_i(c_i, l_i) = c_i - \frac{l_i^{1+k}}{1+k} \tag{4.8}$$

In that case, the compensated labour supply elasticity is equal to $\frac{1}{k}$, and the value of parameter k is chosen in order to be consistent with empirical values of e. Individuals have heterogeneous abilities. Formally, they are endowed with skills w_i such that for every individual $y_i = w_i l_i$. Using the first order condition of the individual problem, it is possible to express the earnings as a function of the labour supply elasticity, the tax rate and individuals' ability:

$$y_i = w_i^{e+1}(1-\tau)^e$$

In the absence of income effects, the pre-tax earnings of individuals are not affected by the level of the universal transfer. I follow the approach developed in Saez (2001) that consists in using this expression to retrieve the exogeneous distribution of skills using the observed distribution of earnings, the current tax rate and a chosen distribution of e. I use the current distribution of earnings in France taken from the World Inequality Database and an approximation of the actual linear tax rate of 50 percent, that roughly corresponds to the share of national income that is taxed. With the calibrated exogeneous distribution of skills at hand, it is possible to compute the welfare of individuals under different tax systems (federal or competition), and scenarios (varying elasticities values and distribution and government redistributive tastes), taking the distribution of skills as fixed conditionally on the distribution of labour supply elasticities. This methodology allows to take into account all changes in the earnings distribution (and thus collected tax revenue) that are caused by changes in the tax rates due to different tax systems considered, but also by different assumptions on elasticities' distribution. Regarding the value of the labour supply elasticity e, I use for the calibrations a constant value of 0.25 that is in line with the value widely used and estimated in the literature.

Regarding preferences for redistribution, a first case to consider is the most redistributive government, that is to say a Rawlsian government that only values the welfare of the bottom fifty percent such that $g_i = 1$ for any i in the bottom fifty percent while $g_i = 0$ for anyone else. It is then possible to consider different shape of the government preferences for redistribution, through variations in the value of the parameters g_i, and therefore $\bar{g}$. I consider two types of government: a *highly redistributive government* that values the welfare of each individual in the bottom fifty percent five times more than the welfare of individuals in the other deciles, and a *moderately redistributive government* that values the welfare of each individual in the bottom fifty percent two times more than individuals in the other deciles.

The last parameter needed, and the most central in the analysis, is the migration elasticity parameter. As showed in the previous section, the optimal linear tax rate depends on the overall mobility parameter $\bar{\varepsilon}$. This global mobility parameter is determined by the income-weighted average mobility elasticity and the population-weighted average mobility elasticity, that both depend on one relevant sufficient statistics: the migration elasticity with respect to the net-of-tax rate at each income level. The policy-relevant parameter is therefore ε_i, the elasticity of the *stock* of type-i individuals with respect to the net-of-tax rate. As emphasized by Kleven et al. (2019), there is a lack of empirical evidence on the empirical value of ε_i, especially for broad labour market segments and low levels of income. Importantly, as underlined by Kleven et al. (2019), ε_i is not a structural parameter but is affected by many environmental factors, such as the size of jurisdictions, current differences in tax rates, and levels of cooperation. The values of the elasticity ε_i may be varying over time, and across countries. For now, there is little empirical evidence on *cross-country* mobility responses to taxation. This is mainly because data on international migration flows are very hard to obtain, and because tax changes and mobility responses are likely to be endogeneous, and it is therefore difficult to find an empirical setting allowing to estimate a causal effect of taxation on mobility.

Two seminal contributions have managed to get around these empirical challenges by using original tax reforms and individual-level data for specific occupations allowing to track individuals' residence. Kleven et al. (2013) use data on the international carreer of football players in order to track their mobility choices, whileAkcigit et al. (2016) make use of international patents data to infer inventors' residence mobility. Kleven et al. (2013) and Akcigit et al. (2016) estimate sizeable elasticities of migration for top earners with specific occupations (football players and inventors), and find that mobility responses to taxation are especially large for foreigners, with elasticities around one, or above. This finding is confirmed by Kleven et al. (2014) who study the effect of a preferential tax scheme targeted on top earners immigrants in Denmark, and find a migration elasticity of 1.5. The reason why these studies have distinguished the mobility responses to taxation between foreigners and domestic is because they originally exploited quasi-natural variations stemming from tax reforms targeted on foreigners. However, the parameter of interest for the revenue-maximizing government is the elasticity of the overall stock of top earners, rather than the elasticity of the flows, or the foreigners elasticity. The stock elasticity will of course be lower, as by definition it relates to a larger base. For instance, Kleven et al. (2013) estimate that the elasticity of the number of football players with respect to the net-of-tax rate (the *uniform* elasticity) is between 0.1 and 0.4 on average, while the migration elasticities of foreigners alone is 0.7. Another strand of literature has focused on within-country mobility responses to taxation, exploiting the effects of regional-level variations in tax rates on individuals' mobility. Studying within-US mobility of inventors, Moretti and Wilson (2017) estimate an elasticity of the flow of inventors with respect to personal income tax rate of 1.5, that translates to a lower stock elasticity of between 0.4 and 0.5. In a recent contribution, Agrawal and Foremny (2018) exploit regional-variations in the the level of personal income tax rates within Spain and find that the elasticity of the stock of top earners is around 0.8. In a recent work, Muñoz (2019a) estimates migration elasticities for the top ten percent employees of 26 European countries. The results show that the location choices of European top ten percent employees are significantly affected by variations in top income tax rates. This translates to a large elasticity of migration of foreigners (around 1.5), and a much lower uniform migration elasticity, that is between 0.1 and 0.4 on average.[4]

Regarding migration responses at the bottom of the income distribution, there are very few empirical studies that have tried to quantify migration responses to taxation for all earners, and even fewer studies that have looked at migration responses of bottom earners to transfers. Some papers have however found that elderly migration within the US may have been partially driven by taxes and state-level policies in terms of amenities (Conway and Rork (2006); Conway and Houtenville (2001)). Overall, migration responses of low and middle earners to taxes and transfers remains a blackbox.

Regarding the results of the empirical literature described above, I consider an interval for the value of ε_i of [0.1;0.4]. These values are small, as they are far from the unity, and are close to the values that have been estimated by the literature for standard labour supply elasticities. Of course, the magnitude of ε_i could be much higher if the migration area is restricted to very small jurisdictions, or a highly integrated set of countries. In this case, the migration elasticity could be closer to the higher stock elasticity that has been estimated for within-country mobility responses to taxes, as in Martinez (2017) or Agrawal and Foremny (2018). As I lack evidence on the value of ε_i for the entire range of income levels, I will start with the assumption that mobility responses are constant across earnings levels. I will then relax this assumption, and investigate various scenarios regarding the distribution of the mobility elasticity with income (the semi-elasticity).

Results

The baseline results of the numerical calibrations are presented in Table 4.1 and Figure 4.1 using the French earnings distribution. I use as the baseline scenario a constant labour supply elasticity of 0.25 and a migration elasticity that is constant across earnings types, meaning that all the ε_i have the same *absolute* magnitude. This implies that at all income levels, individuals have the same migration response to a change in their consumption caused by a change in taxes, except that tax changes have an opposite effect on individuals' consumption depending on which side of the break-even point they are. Using the theoretical formulas of the optimal linear tax rates, I compute the optimal linear tax rates in the federal and the competing unions for different redistributive tastes and various values for the migration elasticity. Given these optimal tax rate, I use the first order condition of the individual problem together with the exogeneous skills distribution to compute their optimal amout of labour supply and pre-tax earnings under each tax systems and scenarios. The transfers for each tax systems and scenarios are determined by the sum of these pre-tax earnings. I finally compute the welfare of individuals under each tax system using the utility specification presented in Equation (4.8). The welfare effect of tax competition is given by the change in welfare from

[4] The estimated elasticities are presented in Table D.1 for a given set of European countries. The migration elaticities for the top ten percent range on average from 0.15 to up to 0.8 for some countries, and are heterogenous across member states, due to countries sizes and tax bases characteristics. For France, the migration elasticity for the top decile is estimated in the range [0.30;0.45].

going from a federal union to a competition union. These changes are summarized for the bottom ten and fifty percent in Table 4.1. I show the full distribution of welfare gains and losses created by tax competition across all earnings deciles in Figure 4.1. In Table D.3, I relax the assumption of constant elasticities and investigate the special case where tax-driven migration is only present at the top of the income distribution.

4.3 Non Linear Tax Schedule with Discrete Income Brackets

To take into how the tax progressivity of tax systems may be affected by the presence of tax competition, I develop a discrete version of the Mirrlees model, following Piketty (1997) and Saez (2002), in the presence of migration. The discrete non linear case has the advantage to be more tractable than the non linear model with continuous types, and to shed light on marginal tax rates at in the top and bottom brackets. Compared to the linear analysis developed before, it also allows to better take into account how the progressivity of the tax system can be affected by the magnitude and the distribution of migration elasticities.

4.3.1 Baseline Framework

Agents are indexed by k and are endowed with continuously distributed skills w_k, but there is a finite numbers of tax brackets, or occupations, $i = 0, ..., I$. Each tax bracket provides a wage y_i for $i = 0, .., I$, with $y_0 = 0$. Earnings y_i are increasing with i, and I start by assuming that there is a perfect substitution of labour types in the production function, implying that pre-tax wages are fixed. The government cannot directly observe individuals' skills and has to condition taxation on the observable income levels. The tax function is non-linear, and depends on the level of earnings, such that individuals in bracket-i have an overall tax liability $T(y_i) = T_i$.

Similarly than before, individuals have a utility function $u^k(c_i, k(i))$ that is a function of their tax-bracket choice $k(i)$ and the after-tax income level in their bracket c_i. Given their abilities, preferences and the tax and transfer schedule $(c_0, ..., c_I)$, agents choose their bracket i in order to maximize their utility. There is a population h_i of agents in each bracket $i \in I + 1$, and $\sum_i h_i = N$ is the total population in the country. As in the linear model, agents respond to distortions created by taxation through labour supply changes, that are captured by their choices of income brackets. Labour supply decisions of individuals are thus loaded in the function $h_i(c_0, c_1 ...., c_I)$. I assume that the tastes for work embodied in the individual utilities are smoothly distributed so that the aggregate functions h_i are differentiable. As before, I consider as an important simplification the case with no income effects. In this case, increasing all after-tax consumption levels by a constant amount does not affect the distribution of individuals across brackets.

In this model, $T(y_i)$ embeds all taxes and transfers received by each individual. Compared to the simplistic linear case studied before, the more complex non-linear tax schedule allows to explore at a finer level variations in the profile of transfers depending on the level of revenues. The non-linear tax system is characterized by two key concepts. First, the universal demogrant $-T(0) = T_0$ that is distributed to everyone. Second, the marginal tax rate $T'(y_i)$ that captures the taxation on transitions from one bracket to another.

The marginal tax rates, also called the phasing-out rates, allow to take into account the distributive effects of income taxation in the presence of behavioural responses to taxation. It also allows to capture at which rate the lumpsum grant is taxed away, and how the tax liability increases with earnings. A negative value for $T_i(y_i)$ means that individuals receive a net transfer from the government, and has to be distinguished from a negative value for the taxation rate on occupations transitions defined by $(T_i - T_{i-1})/(c_i - c_{i-1})$. There is an i for which $T_i = 0$, and as in the linear case I call this income level the break-even point. An important feature of the optimal tax problem is that it does not produce an explicit formula for the optimal transfer -T(0). The guaranteed income is determined in general equilibrium, and results from the optimal tax and transfer schedule T_i, and the empirical densities h_i determined by the tax schedule. The amount of taxes and transfers in each bracket T_i are set by the government in order to maximize a total welfare function. The government budget constraint is a function of the tax schedule and the endogeneously determined density of individuals in each income bracket:

$$R = \sum_{i=0}^{I} h_i T_i \tag{4.9}$$

Where R is exogeneously determined. There are several types of welfare functions that can be considered regarding the optimal tax problem. I start by studying a revenue-maximizing government. Then I consider a government that maximizes the total welfare in the economy, using the concept of generalized social welfare weights, where g_i captures the weight given to additional consumption for individuals in the tax bracket i, as in the linear analysis.

I extend the model to the case where individuals can react to taxation with migration. Similarly than in the linear model, in the presence of tax competition, taxation affects individuals' choices at the intensive margin regarding their choice of income bracket, and at the extensive margin through their migration choices. Conditional of being in the bracket i, individuals choose to migrate from A to country B if their utility is higher in country B. The migration condition considered in the linear case is unchanged, except that the tax system is now non-linear, and T_i directly loads the total tax liability of type-i individual:

$$u_i^A = y_i - T_i^A - v_i(y_i, l_i) + \theta_i^A - m \tag{4.10}$$

$$u_i(c_i^A, y_i, \theta_i^A, m) \geq u_i(c_i^B, y_i, \theta_i^B, m) \tag{4.11}$$

As before, the migration condition establishes that location choices are driven by differences in tax liabilities between the two countries, and the density of individuals in one country is therefore a function of its tax liability in this country. As in the linear framework, in the presence of tax competition the number of individuals in the national bracket i becomes a function of the tax and transfer schedule in this country $h_i(c_i)$. Migration decisions are thus driven by average tax liabilities, by contrast to occupation decisions that are driven by taxation on transitions from one bracket to another. The migration responses to taxation can be summarized in terms of elasticity concepts. By contrast to the linear case, individuals' consumption does not depend on a net-of-tax average rate, but of the amount of taxes paid and transfers received T_i. Therefore, I define the migration elasticity as the change in the density of type-i individuals locating in country A when their *disposable income* in country A is increased by one percent:

$$\xi_i = \frac{\partial h_i}{\partial c_i} \times \frac{c_i}{h_i} \tag{4.12}$$

Note that ξ_i is similar to ε_i for individuals with above the break-even point, and of opposite sign for individuals with income levels below the break-even point. As I define the migration elasticity with respect to consumption in the linear case, it is positive at all income levels.

4.3.2 Intensive Model

In this section, I present the canonical intensive model first developed by Piketty (1997) and Saez (2002) where individuals respond to taxation through labour supply choices only. In this model, a change in consumption level in any bracket i relative to another bracket $i-1$ induces individuals to switch from bracket i to bracket $i-1$. For simplicity, I assume that agents can only choose between adjacent occupations, and therefore, h_i is only a function of c_i, c_{i+1} and c_{i-1}. I define the elasticity of the number of individuals in bracket i with respect to the differences in consumption $c_i - c_{i-1}$

$$\eta_i = \frac{\partial h_i}{\partial (c_i - c_{i-1})} \times \frac{(c_i - c_{i-1})}{h_i} \tag{4.13}$$

As outlined by Piketty (1997), η_i captures the transition of individuals to bracket $i-1$ to bracket i when the difference in consumption between the two brackets is increased. The parameter η_i captures the participation of each individual in bracket i, and can be easily linked to the earnings elasticity e_i. Following Saez (2002), I use the relationship $\eta_i y_i = e_i(y_{i-1} - y_i)$. Hence, with intensive responses at the labour supply margin, a change in the tax liability in the bracket i will affect the transition rate between the bracket i and the adjacent occupations. The maximization of the government tax revenue leads to the first order condition:

$$h_i = T_{i-1}\frac{\partial h_{i-1}}{\partial (c_i - c_{i-1})} - T_{i+1}\frac{\partial h_{i+1}}{\partial (c_{i+1} - c_i)} + T_i\frac{\partial h_i}{\partial (c_i - c_{i-1})} - T_i\frac{\partial h_i}{\partial (c_{i+1} - c_i)}$$

The optimal tax liability of the revenue-maximizing government is given by:

$$\frac{T_i - T_{i-1}}{c_i - c_{i-1}} = \frac{h_i + h_{i+1} + ... + h_I}{h_i \eta_i} \tag{4.14}$$

The proof is formally derived in the Appendix D.1.4. Using τ_i the implicit marginal tax rate on bracket i such that $\tau_i = (T_i - T_{i-1})/(Y_i - Y_{i-1})$, where $1 - \tau_i = c_i - c_{i-1}/Y_i - Y_{i-1}$, and $a_i = Y_i/(Y_i - Y_{i-1})$, we obtain the formula for the optimal marginal tax rate on bracket i in the case where individuals can only respond to taxation through labour supply choices. This corresponds to the case of a federal government composed by symetric countries. When countries set the same tax and transfer schedule and are symetric such that before-tax salaries are equal, there is no differences in consumption between home and abroad that is affected by taxation. Therefore, migration decisions are independent from T_i, and do not affect the optimal tax formula. Optimal Marginal Tax Rate of the Revenue-Maximizing Federal Government:

$$\tau_i^f = \frac{h_i + h_{i+1} + ... + h_I}{h_i + h_{i+1} + ... + h_I + h_i a_i e_i} \tag{4.15}$$

The proof is formally derived in the Appendix. As outlined by Saez (2002), in the absence of extensive margin responses to taxation, the optimal tax liabilities are always increasing with i, and negative marginal tax rates are therefore never optimal.[5] As a result, the marginal tax rate in the first bracket is very high, and is maximal in the Rawlsian case with high redistributive taste. In complement to the formal maximization of the government problem given in the Appendix, it is possible to provide a simple and intuitive proof of Equation 4.15 by studying a small deviation in the tax schedule. Consider a small change dT for all brackets $i, i+1, ..., I$. This change in taxation changes $c_i - c_{i-1}$, leaving all other differences in consumption levels unchanged. This change in tax liabilities induces a mechanical increase in collected revenue equal to $(h_i + h_{i+1} + ... + h_I)dT$. The change in taxation also induces a behavioral response through the change in transition from bracket i to $i-1$. Using the definition of the participation elasticity, the mass of taxpayers in bracket i changes by $dh_i = -h_i \eta_i dT/(c_i - c_{i-1})$, inducing a loss in tax revenue of $dhi(T_i - T_{i-1})$. Summing the behavioural and mechanical effects to zero, we retrieve the formula for the optimal tax formula in the pure intensive model.

4.3.3 Extensive Model

I now turn to the extension of the canonical model, allowing migration responses to taxation. To emphasize how the tax driven mobility affects the non linear tax schedule, I start by considering the pure extensive model, where individuals can only respond to taxation through migration. This means that given their location decision, individuals' earnings are fixed. The only effect of T_i on h_i is therefore through migration responses to taxation summarized by Equation (4.10). The revenue-maximizing government chooses the optimal T_i taking into account the endogeneous changes in h_i due to migration responses to taxation, and the optimal tax and transfer schedule for type-i individuals satisfies:

$$\frac{T_i}{y_i - T_i} = \frac{1}{\xi_i} \tag{4.16}$$

The proof of Equation Equation (4.16) is derived in the Appendix. I give a simple intuition of the formula studying a small deviation in the tax schedule when individuals respond to taxation through migration only. In the pure extensive model, the change in tax liability T_i has an effect on migration decisions of individuals in bracket i, but does not affect transition to adjacent brackets. The change in T_i produces a mechanical increase in collected tax revenue $h_i dT_i$. The reform also creates a behavioral effect through migration, with a change in taxpayers mass of $dh_i = -h_i dT_i / c_i \xi_i$. Each individual emigrating from the country induces

[5] The fact that negative marginal tax rates are never optimal would plausibly hold even considering participation margin at the bottom of the income distribution in that model. This is because the government is Ralwsian, which implies that the underlying welfare weights are very high for unemployed, and lower for poor workers.

a loss of its overall tax liability T_i, and the overall behavioral effect is therefore $-h_i dT_i/c_i\xi_i T_i$. Summing behavioural and mechanical effects to zero gives the formula for the optimal tax and transfer schedule for each income bracket i. The marginal tax rate from bracket i to bracket $i-1$ is therefore given by

$$\frac{T_i - T_{i-1}}{c_i - c_{i-1}} = \frac{1}{ci - c_{i-1}}\left(\frac{y_i}{1+\xi_i} - \frac{y_{i-1}}{1+\xi_{i-1}}\right)$$

4.3.4 Optimal Linear Tax Rate in Tax Competition

I finally put together the pure intensive and extensive model to consider the case where individuals respond to taxation through migration and labour supply behavioural reponses. With a sligh abuse of notation, I rewrite the population function of taxpayers in the country as $h_i(c_i - c_{i-1}, c_{i+1} - c_i, c_i)$. The first two terms capture the effect of taxation on transition to adjacent tax brackets, while the last term captures the effect of taxation on utility differentials between home and abroad through consumption at home c_i. The derivation of the government tax revenue with respect to T_i is given by:

$$h_i = (T_i - T_{i-1})\frac{\partial h_i}{\partial(c_i - c_{i-1})} + (T_{i+1} - T_i)\frac{\partial h_i}{\partial(c_{i+1} - c_i)} + T_i\frac{\partial h_i}{\partial c_i}$$

Making use of the set of first order condition and the fact that $\dfrac{\partial h_i}{\partial(c_i - c_{i-1})} = \dfrac{-\partial h_{i-1}}{\partial(c_i - c_{i-1})}$, I obtain an expression for the optimal non linear tax rate chosen by a revenue-maximizing government in the competition union. Optimal Revenue-Maximizing Marginal Tax Rate in Tax Competition:

$$\tau_i^c = \frac{h_i(1 - b_i\xi_i) + h_{i+1}(1 - b_{i+1}\xi_{i+1}) + ... + h_I(1 - b_I\xi I)}{h_i(1 - b_i\xi_i) + h_{i+1}(1 - b_{i+1}\xi_{i+1}) + ... + h_I(1 - b_I\xi_I) + h_i a_i e_i} \tag{4.17}$$

The optimal tax rate formulas are formally derived in the Appendix. The formula for the optimal non linear tax rate in tax competition can also be retrieved by using a small deviation in the tax schedule. I consider a small deviation dT for all tax bracket $i, i+1, ..I$. As in the pure intensive model, this change in taxation modifies $c_i - c_{i-1}$, leaving all other differences in consumption levels unchanged. The change in tax liabilities induces a mechanical increase in collected revenue equal to $(h_i + h_{i+1} + ... + h_I)dT$. The change in taxation also induces a behavioral response through the change in transition from bracket i to $i-1$. Using the definition of the participation elasticity, the mass of taxpayers in bracket i changes by $dh_i = -h_i\eta_i dT/(c_i - c_{i-1})$, inducing a loss in tax revenue of $dhi(T_i - T_{i-1})$. In the presence of tax competition, there is an additional effect on tax revenue due to migration responses to taxation. As migration decisions are driven by overall tax liabilities, the change dT creates a migration response in all brackets affected by the change. Using the definition of the migration elasticity, the change in the number of taxpayers due to the tax reform can be written $-dT(\frac{h_i}{c_i}\xi_i + \frac{h_{i+1}}{c_{i+1}}\xi_{i+1}... + \frac{h_I}{c_I}\xi_I)$. Any individual migrating from the country imposes a loss in tax revenue equal to its overall tax liability, such that the effect of tax-driven migration on tax revenue is equal to $-dT(\frac{h_i}{c_i}T_i\xi_i + \frac{h_{i+1}}{c_{i+1}}T_{i+1}\xi_{i+1}... + \frac{h_I}{c_I}T_I\xi_I)$. Note that by contrast to the linear case, the *revenue and transfer channels* are simultaneously captured by the overall tax liability T_i, that can either be positive or negative. Summing the behavioural and mechanical effects to zero yields the optimal tax formula.

Letting one of the two elasticities e_i and ξ_i tend to zero in Equation (4.17), we retrieve the optimal formula of the pure extensive and intensive models. The optimal tax formulas make use of two fundamental parameters that relate to the two distortions implied by the intensive and extensive behavioural responses to taxation. The labour supply responses is weighted by the discrete equivalent of the usual Pareto parameter $a_i = Y_i/(Y_i - Y_{i-1})$ that captures the relative gain from the income bracket transition taxed at the marginal rate τ_i, while the migration response is weighted by the parameter $b_i = T_i/(y_i - T_i)$, emphasizing how location choices are driven by average tax rates. The migration wedge b_i is negative for individuals with income level below the break-even point, leading the overall migration response $b_i\xi_i$ of bottom earners to be negatively weighted in the optimal tax formula, making the link between the optimal tax formula derived in the linear framework.

The optimal marginal rates in the discrete linear case are, as it is well known, U-curved, with high and decreasing marginal rates at the bottom of the distribution, and increasing marginal rate at the top of the distribution. Of particular interests are the optimal top and bottom marginal tax rates. The optimal formulas in Equation (4.17) relate to the extreme case of a revenue-maximizing government, where the social planner exclusively values redistribution towards zero earners. As emphasized by Piketty and Saez (2013), this specific case of social preferences is likely to generate high values for the optimal bottom marginal tax rate τ_1. This is because increasing the transfers by increasing the phase-out rate produces a moderate behavioral cost, as individuals who decide to leave the labor force would have had low earnings should they work. As a result, in the presence of extensive and intensive responses to taxation, the optimal phase-out rate chosen by the Ralwsian government is positive, and very high.

As emphasized by Proposition 4.3.4, tax competition modifies the optimal tax and transfers schedule compared to the federal system summarized by Proposition 4.3.2, to an amount that is proportional to the migration tax wedges b_i that are negative for low income levels, and the mobility elasticities ξ_i. In the non-linear case, the effect of migration on the universal demogrant through the amount of taxes paid and the amount of transfer received is directly loaded in the term T_i that captures the net amount of taxes and transfers received or paid by the individual in bracket i. To simply illustrate this fact, and link the migration wedge b_i to the trade-off between the income and population weighted mobility parameter faced by the government in the linear case, I present the derivation of the optimal non-linear tax rate in the presence of migration by making the distinction between the amount of taxes paid $\tilde{T}_i$ and the amount of transfer received by everyone T_0. The resulting optimal linear tax rate is the same than the one presented in Proposition 4.3.2 with alternative notations. In this case, the government seeks to maximize $\frac{1}{\sum_i h_i}\sum_i h_i\tilde{T}_i$, where the total number of taxpayers $N = \sum_i h_i$ is endogeneously affected by the tax schedule through migration responses to taxation. With $N = \sum_i h_i$ and $R = \sum_i h_i\tilde{T}_i$, the first order condition of the government with respect to the amount of taxes $\tilde{T}_i$ can be rewritten as $\frac{1}{N^2}(\frac{\partial R}{\partial \tilde{T}_i} \times N - \frac{\partial N}{\partial \tilde{T}_i} \times R) = 0$ which is equivalent to $\frac{\partial R}{\partial \tilde{T}_i} = \frac{\partial N}{\partial \tilde{T}_i} \times \frac{R}{N}$. Intuitively, the government first order condition with respect to $\tilde{T}_i$ indicates that at the optimum, the change in tax revenue due to a distortion in type-i individuals tax liability has to be offset by the change in transfer caused by the change in the number of type-i taxpayers implied by the tax reform, such that the net effect of the reform is equal to zero in the optimum. As before, I consider a small change $d\tilde{T}$ on tax brackets $i, i+1..., I$. The change $d\tilde{T}$ causes a change in the density of taxpayers in all brackets affected by the tax reform that is equal to $d\tilde{T}(-h_i\frac{\xi_i}{c_i} - h_{i+1}\frac{\xi_{i+1}}{c_{i+1}} - ... - h_I\frac{\xi_I}{c_I})$. Each migration response to taxation induces a fiscal lost equal to individual's overall tax liability. When the absolute number of taxpayers is changed by the small tax deviation, there is an additional effect of migration on the government tax revenue, through the change in the number of transfers' benificiaries, and each individual emigration yields a fiscal gain equal to the universal demogrant $T_0 = -T(0)$. It follows that the net effect of migration responses to taxation of $d\tilde{T}$ is equal to $-d\tilde{T}(h_i\frac{\xi_i}{c_i}(\tilde{T_i} - T_0) + h_{i+1}\frac{\xi_{i+1}}{c_{i+1}}(\tilde{T_{i+1}} - T_0) + ... + h_I\frac{\xi_I}{c_I}(\tilde{T_I} - T_0))$. The overal effect of $d\tilde{T}$ on the universal demogrant is therefore $d\tilde{T}(h_i + h_{i+1} + ... + h_I - \frac{T_i - T_{i-1}}{c_i - c_{i-1}}h_i\eta_i - \xi_i\frac{\tilde{T_i} - T_0}{c_i}h_i - \xi_{i+1}\frac{\tilde{T_{i+1}} - T_0}{c_{i+1}}h_{i+1} - ... - \xi_I\frac{\tilde{T_I} - T_0}{c_I}h_I)$. The mobility response of individuals in each bracket-i is weighted by $b_i = (\tilde{T_i} - T_0)/c_i = T_i/c_i$, meaning that the trade off between the revenue and the transfer channel of tax driven migration responses emphasized in the linear case is captured by the migration wedge b_i in the non linear case.

4.3.5 Welfare Weights

I finally turn to the derivation of the optimal non linear tax tax and transfers schedule relying on the more general concept of generealized social marginal welfare weights. These formulas will be used in the numerical simulations, as they allow to capture the effects of government's tastes for redistribution on the optimal tax rates, and ultimately on the welfare effects of tax competition. As I will show later, the formulas of the optimal non linear tax rate with discrete earnings and welfare weights allow to emphasize simply the effects of tax-driven mobility on redistribution. I use the concept of generalized marginal social welfare weights, to be fully consistent with the approach presented for the linear framework. As before, the government attributes a weight g_i to type-i individuals' consumption, and the optimal tax schedule is such that any small tax deviation is welfare neutral. Optimal Non-Linear Marginal Tax Rates in Federal Union:

$$\tau_i^f = \frac{h_i(1-\bar{g}_i) + h_{i+1}(1-\bar{g}_{i+1}) + ... + h_I(1-\bar{g}_I)}{h_i(1-\bar{g}_i) + h_{i+1}(1-\bar{g}_{i+1}) + ... + h_I(1-\bar{g}_I) + h_i a_i e_i} \tag{4.18}$$

With $\bar{g}_i = g_i/(\sum_{m=0}^{I} h_m g_m \times N)$. The proof is derived below. Optimal Non-Linear Marginal Tax Rates in Tax Competition:

$$\tau_i^c = \frac{h_i(1-b_i\xi_i-\bar{g}_i) + h_{i+1}(1-b_{i+1}\xi_{i+1}-\bar{g}_{i+1}) + ... + h_I(1-b_I\xi_I-\bar{g}_I)}{h_i(1-b_i\xi_i-\bar{g}_i) + h_{i+1}(1-b_{i+1}\xi_{i+1}-\bar{g}_{i+1}) + ... + h_I(1-b_I\xi_I-\bar{g}_I) + h_i a_i e_i} \tag{4.19}$$

With $\bar{g}_i = g_i/(\sum_{m=0}^{I} h_m g_m \times N)$. The proof is derived below. As in the linear case, I derive the optimal non linear tax rate using the small perturbation method with generalized social marginal weights, where the optimal tax schedule is such that no welfare gain can be acchieved through a small reform.[6]

[6] See Saez and Stantcheva (2016) for a discussion on the local derivation of the optimuum with generalized social marginal weights.

Consider again a small tax deviation dT on tax brackets $i, i+1..., I$. The deviation causes a mechanical increase in tax revenue $dT(h_i + h_{i+1} + ... + h_I)$. In addition to the mechanical change in revenue collected due to the tax reform, the small tax deviation creates behavioural responses to taxation. In the federal union, there is no migration responses to taxation, and the only behavioural response to taxation is through labour supply responses to the tax reform. The tax reform dT modifies transition to bracket $i-1$ to bracket i, and the density of taxpayers in the bracket i is changed by the amount $dh_i = -h_i \eta_i dT/(c_i - c_{i-1})$ at a net fiscal cost $(T_i - T_{i-1})$. The total effect of the reform on the government tax revenue is therefore $dT(h_i + h_{i+1} + ... + h_I - \frac{T_i - T_{i-1}}{c_i - c_{i-1}} h_i \eta_i)$. What is the effect on individuals welfare of the reform in the federal union? By definition of the general welfare weights, any increase in type-i individuals' consumption has a value g_i for the government. From bracket i to I, individuals have to pay additional taxes and the effect on their welfare is $-dT(h_i g_i + h_{i+1} g_{i+1} + ... + h_I g_I)$.The tax reform also increases the amount of transfer received by everyone such that the effect of the tax reform on total welfare through the change in tax revenue collected is given by $-\frac{dT}{N}(\sum_{m=0}^{I} h_m g_m (h_i + h_{i+1} + ... + h_I - \frac{T_i - T_{i-1}}{c_i - c_{i-1}} h_i \eta_i))$. At the optimum, the welfare effects sum to zero and the optimal marginal tax rate in the federal union is given by $\frac{\tau_i^f}{1-\tau_i^f} = \frac{h_i(1-\bar{g_i}) + h_{i+1}(1-g_{i+1}^{-}h_{i+1})... + h_I(1-\bar{g_I})}{h_i a_i e_i}$ with $\bar{g_i} = g_i/(\sum_{m=0}^{I} h_m g_m \times N$ the normalized welfare weight, and where the population N can be normalized to one without loss in generality. Note that this formula is a discretization of the optimal non linear tax formula provided in Saez and Stantcheva (2016).[7]

I now turn to the evaluation of the optimal non linear tax rate in the case where individuals respond to taxation through migration. As before, the tax reform dT modifies transition to bracket $i-1$ to bracket i, and the density of taxpayers in the bracket i is changed by the amount $dh_i = -h_i \eta_i dT/(c_i - c_{i-1})$ at a net fiscal cost $(T_i - T_{i-1})$. Second, the change dT causes a change in the number of taxpayers in all brackets affected by the tax reform, as migration decisions are driven by overall tax liabilities. This change in the mass of taxpayers is equal to $dT(-h_i \frac{\xi_i}{c_i} - h_{i+1}\frac{\xi_{i+1}}{c_{i+1}} - ... - h_I \frac{\xi_I}{c_I})$. Each migration response induces a net fiscal cost of T_i for the government and it follows that the net effect of migration responses to the reform on the government revenue is $-dT(h_i \frac{\xi_i}{c_i} T_i + h_{i+1}\frac{\xi_{i+1}}{c_{i+1}} T_{i+1} + ... + h_I \frac{\xi_I}{c_I} T_I)$. The overal effect of dT on the government tax revenue is $dT(h_i + h_{i+1} + ... + h_I - \frac{T_i - T_{i-1}}{c_i - c_{i-1}} h_i \eta_i - \xi_i \frac{T_i}{c_i} h_i - \xi_{i+1}\frac{T_{i+1}}{c_{i+1}} h_{i+1} - ... - \xi_I \frac{T_I}{c_I} h_I)$. This increase in tax revenue is rebated lump-sum such that the small reform is budget neutral. What are the effects on welfare of the tax reform dT? The increase in taxes for individuals in brackets $i, i+1, ..., I$ generates a change in the universal demogrant for all individuals in the economy, and this welfare effect can be written $\frac{-dT}{N}(\sum_{m=0}^{I} h_m g_m (h_i + h_{i+1} + ... + h_I - \frac{T_i - T_{i-1}}{c_i - c_{i-1}} h_i \eta_i - \xi_i \frac{T_i}{c_i} h_i - \xi_{i+1}\frac{T_{i+1}}{c_{i+1}} h_{i+1} - ... - \xi_I \frac{T_I}{c_I} h_I)$. The welfare effect for individuals who have to pay the increase in taxes that is equal to $-dT(h_i g_i + h_{i+1} g_{i+1} + ... + h_I g_I)$. Summing the welfare effects to zero, we obtain the formula for the optimal non linear

[7] The formula can be rewritten as $\frac{\tau_i^f}{1-\tau_i^f} = \frac{\sum_{m>i} h_m - \bar{G_i}}{h_i a_i e_i}$ where $\sum_{m>i} h_m$ denotes the mass of taxpayers with income above the income level where the small tax reform applies and $\bar{G_i} = \sum_{m>i} h_m g_m / (\sum_{m=0}^{I} h_m g_m \times N)$ is the discrete equivalent of the average welfare weight parameter in t$\bar{G}(y) = \int_{\{i: y_i > y\}} g_i d_i / (\int_i g_i d_i)$ with population normalized to one.

tax rate in tax competition presented in Equation (4.19).

Comparing Equation (4.19) with Equation (4.18) allows to see how mobility responses to taxation affects the implicit weights given by the government to mobile individuals. Because of b_i, the implicit welfare weight given to mobile individuals is *lowered* for individuals below the break-point, and *increased* for individuals above. The optimal tax formulas in the non-linear discrete framework therefore allow to emphasize how tax competition modifies implicitly the redistributive preferences on the government, and how these *mobility-adjusted* welfare weights may have different values, but also different distribution, because of the transfer channel of tax-driven mobility discussed in the previous section.

4.3.6 Effect of Tax Competition on Individuals' Welfare

I then turn to the numerical simulations of the optimal non linear marginal tax rates schedules. The numerical simulations for the non linear tax schedule are more complex, as they require to find the non linear tax schedule and the distribution of earnings that simultaneously satisfy the government first order condition. In order to compute the welfare effects of tax competition in the non linear tax schedule, I first conduct numerical simulations in order to find the optimal tax and transfer schedules in the federal and competing unions. For this purpose, I use a fixed-point algorithm such that the optimal tax formulas in Equation (4.19) and Equation (4.18) and the optimal conditions of individuals summarized by the behavioural elasticities in Equation (4.13) and Equation (4.12) are simultaneously satisfied. Then, I compute individuals' welfare taking into account the change in the taxes and transfer schedules and the changes in labour supply implied by the changes in taxes. I describe these two steps in details below.

I use a discrete grid of earnings with eight tax brackets based on the same empirical French earnings distribution used in the linear framework. I define h_i as the number of individuals whose earnings fall in the range $[y_i - (y_i - y_{i-1})/2; y_i + (y_{i+1} - y_i)/2]$. The resulting discretized distribution of earnings used for the numerical simulations is presented in Table D.2. In the discrete non linear model, the earnings grid and income levels are fixed, while intensive labour supply responses are loaded in the endogeneously determined population functions h_i. The functional forms chosen for the population functions h_i need to be consistent with the structure of behavioural elasticities defined in Equation (4.13) and Equation (4.12) and should coincide with empirical populations h_i^0 when the tax schedule is equal to the actual tax schedule. As in the linear framework, with symmetric countries, there is no tax-driven migration in equilibrum and the effect of migration on taxpayers' population and densities can be ignored. From Equation (4.13) it is possible to write:

$$h_i = h_i^0 \left(\frac{c_i - c_{i-1}}{c_i^0 - c_{i-1}^0} \right)^{a_i e_i} \tag{4.20}$$

Where $(c_{i-1}^0, c_i^0 ..., c_I^0)$ are the actual after tax schedules. The after-tax schedule used for the simulation is a very simple approximation of the real current after tax schedule, with a linear tax rate of 50 percent and a constant transfer of 5,000 euros. However, the results of the numerical simulations show very little sensitivity to the initial tax schedule used to solve the model. Using the functional form for h_i and the exogeneously chosen g_i, I find the tax and transfer schedules such that the optimal conditions of the government summarized in Proposition 5 and Proposition 6 and the behavioural responses summarized by Equation (4.20) are simultaneously satisfied.

With these optimal non-linear tax schedules at hand, I turn to the welfare analysis. As in the linear case, individuals' welfare is computed using the functional form described by Equation (4.8). The change in welfare from the federal union to the competition union is caused by the change in the optimal tax and transfer schedule and the change in labour supply that is loaded in the change of the endogeneous mass of tax payers h_i. The results of the numerical simulations are presented in Table 4.2 and Figure 4.2, while the shape of the optimal tax schedule is displayed in Figure 4.3.

4.4 Conclusion

This paper quantifies the welfare effects of tax competition. The results show that individuals in the bottom fifty percent of the income distribution always lose from tax competition, and would always be better off in a federal union. Their loss in welfare ranges on average from -10 to -20 percent, depending on the redistributive tastes of the government and the strenght of mobility responses to taxation. By contrast, higher income earners benefit from tax competition, as taxes are lowered by mobility responses to taxation when countries engage in tax competition.

These welfare estimates are based on three restrictive assumptions that imply that they are a lower bound for the real welfare effects of tax competition. The first restrictive assumption is that redistribution is viewed as not productive, as the government only reallocates consumption across individuals. In the case where public spending would generate externalities, say through investment in education or health, the welfare effects of tax competition may be increased. The second assumption is that the analysis is performed in a perfectly symmetric union, where there is no migration in equilibrium because the neighbouring countries mimic their tax policies. The welfare analysis therefore quantifies the effects of migration threat on individuals welfare, rather than the fully specified effects of migration. In the case of the migration equilibrium with asymmetric countries, earnings and transfers will be changed in equilibrium. The last assumption is that wages are assumed exogeneously fixed. When tax-driven mobility changes pre-tax earnings, individuals' welfare will be affected by tax-competition through the effects of mobility on pre-tax earnings.

David R. Agrawal and Dirk Foremny. Relocation of the rich: Migration in response to top tax rate changes from spanish reforms. *Review of Economics and Statistics*, 2018.

Ufuk Akcigit, Salomé Baslandze, and Stefanie Stantcheva. Taxation and the international mobility of inventors. *American Economic Review*, 106(10):2930–81, 2016.

Tomer Blumkin, Efraim Sadka, and Yotam Shem-Tov. International tax competition: Zero tax rate at the top re-established. *International Tax and Public Finance*, 22(5):760–776, 2015.

Karen Smith Conway and Andrew Houtenville. Elderly migration and state fiscal policy: Evidence from the 1990 census migration flows. *National Tax Journal*, pages 103–123, 2001.

Karen Smith Conway and Jonathan C. Rork. State "death" taxes and elderly migration—the chicken or the egg? *National Tax Journal*, pages 97–128, 2006.

Ravi Kanbur and Michael Keen. Jeux sans frontieres: Tax competition and tax coordination when countries differ in size. *American Economic Review*, (83):877–892, 1993.

Michael Keen and Kai Konrad. The theory of international tax competition and coordination. In A. Auerbach, R. Chetty, M. Feldstein, and E. Saez, editors, *Handbook of Public economics*, volume 5, pages 257–328. Elsevier, 2013.

Henrik Kleven, Camille Landais, Mathilde Muñoz, and Stefanie Stantcheva. Taxation and migration: Evidence and policy implications. *prepared for the Journal of Economic Perspectives*, 2019.

Henrik J. Kleven, Camille Landais, and Emmanuel Saez. Taxation and international migration of superstars: Evidence from the european football market. *American Economic Review*, 103(5):1892–1924, 2013.

Henrik J. Kleven, Camille Landais, Emmanuel Saez, and Esben A. Schultz. Migration and wage effects of taxing top earners: Evidence from the foreigners' tax scheme in denmark. *Quarterly Journal of Economics*, 129(1):333–378, 2014.

Etienne Lehmann, Laurent Simula, and Alain Trannoy. Tax me if you can! optimal nonlinear income tax between competing governments. *Quarterly Journal of Economics*, 129(4):1995–2030, 2014.

Isabel Martinez. Beggar-thy-neighbour tax cuts: Mobility after a local income and wealth tax reform in switzerland. 2017. LISER Working Paper Series 2017-08.

James A. Mirrlees. An exploration in the theory of optimum income taxation. *Review of Economic Studies*, 38 (2):175–208, 1971.

James A. Mirrlees. Migration and optimal income taxes. *Journal of Public Economics*, 18(3):319–41, 1982.

Enrico Moretti and Daniel J. Wilson. The effect of state taxes on the geographical location of top earners: Evidence from star scientists. *American Economic Review*, 107(7):1858–1903, 2017.

Mathilde Muñoz. Do european top earners react to labour taxation through migration? 2019a. Working Paper.

Wallace E. Oates. *Fiscal Federalism*. New York: Harcourt Brace Jovanovitch, 1972.

Wallace E. Oates. An essay on fiscal federalism. *Journal of Economic Literature*, 37:1120–1149, 1999.

Thomas Piketty. La redistribution fiscale face au chômage. *Revue Française d'Economie*, 1997.

Thomas Piketty and Emmanuel Saez. Optimal labor income taxation. In A. Auerbach, R. Chetty, M. Feldstein, and E. Saez, editors, *Handbook of Public Economics*, volume 5, pages 391–474. Elsevier, 2013.

Emmanuel Saez. Using elasticities to derive optimal income tax rates. *Review of Economic Studies*, 68, 2001.

Emmanuel Saez. Optimal income transfer programs: intensive versus extensive labor supply responses. *The Quarterly Journal of Economics*, 117(3):1039–1073, 2002.

Emmanuel Saez and Stefanie Stantcheva. Generalized social marginal welfare weights for optimal tax theory. *American Economic Review*, 106(1):24–45, 2016.

Charles M. Tiebout. A pure theory of local expenditures. *Journal of Political Economy*, 64(5):416–424, 1956.

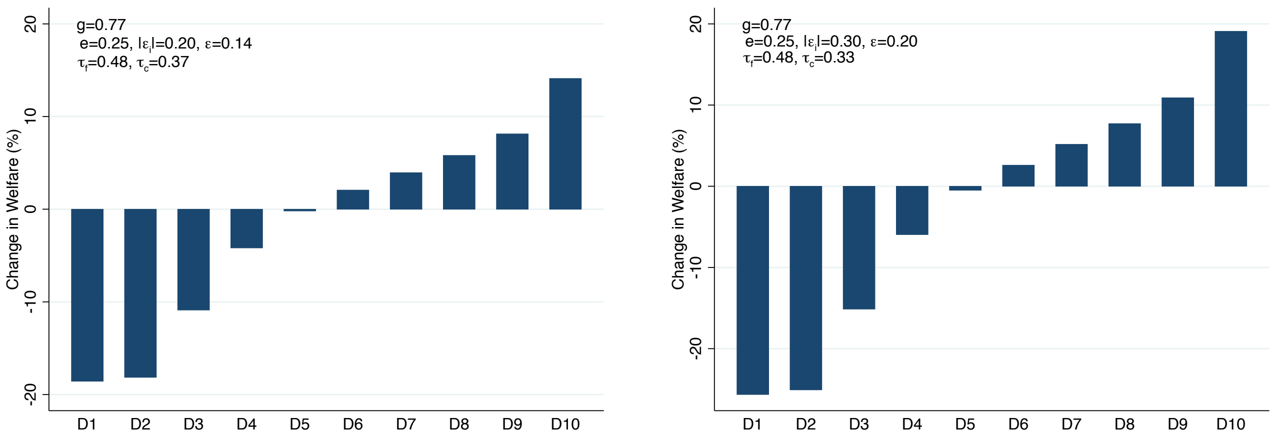
Table 4.1: **Effects of Tax Competition on Optimal Taxes and Welfare With a Linear Tax Schedule**

	Scenario 1 Elasticities e=0.25 $\bar{\varepsilon}$=0.07 $\lvert\varepsilon_i\rvert$=0.1		Scenario 2 Elasticities e=0.25 $\bar{\varepsilon}$=0.14 $\lvert\varepsilon_i\rvert$=0.2		Scenario 3 Elasticities e=0.25 $\bar{\varepsilon}$=0.20 $\lvert\varepsilon_i\rvert$=0.3		Scenario 4 Elasticities e=0.25 $\bar{\varepsilon}$=0.27 $\lvert\varepsilon_i\rvert$=0.4	
I- Optimal Linear Tax Rates								
	Federal	Competition	Federal	Competition	Federal	Competition	Federal	Competition
Rawlsian	0.73	0.68	0.73	0.64	0.73	0.60	0.73	0.57
Highly Redistributive	0.65	0.59	0.65	0.54	0.65	0.50	0.65	0.47
Mod. Redistributive	0.48	0.42	0.48	0.37	0.48	0.33	0.48	0.30
II- Welfare effect of Tax Competition (%)								
	Bottom 10	Bottom 50	Bottom 10	Bottom 50	Bottom 10	Bottom 50	Bottom 10	Bottom 50
Rawlsian	-2.7	-0.7	-6.0	-1.9	-10.3	-4.0	-12.8	-5.2
Highly Redistributive	-5.4	-2.5	-10.7	-5.3	-15.7	-7.9	-20.1	-10.5
Mod. Redistributive	-10.2	-5.7	-18.6	-10.5	-25.7	-14.5	-31.7	-18.0

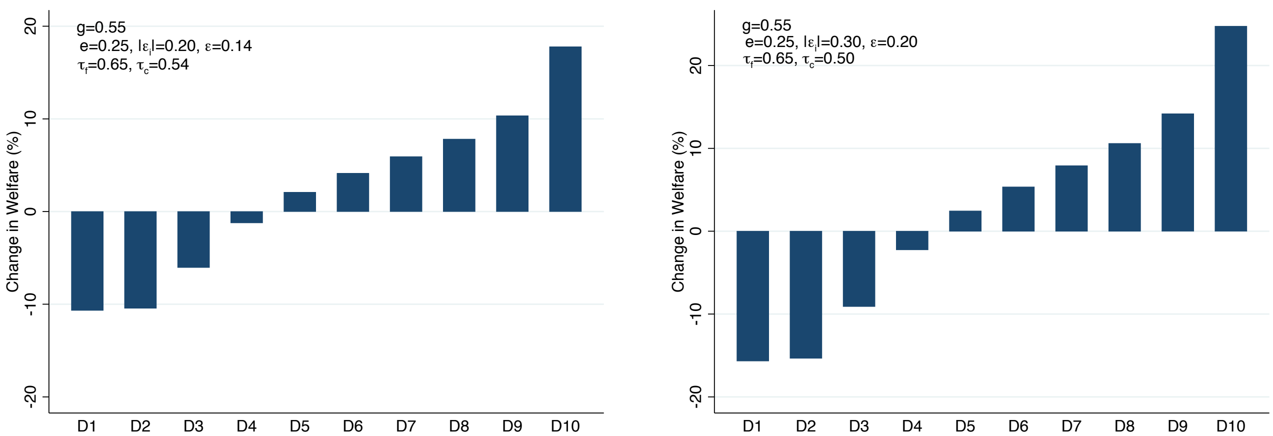
Notes: This Table summarizes the effects of tax competition on optimal tax rates and welfare. The optimal linear tax rates are computed following the formulas presented with more details in the text and presented in Proposition x and Proposition x. The elasticity e_i is the elasticity of type-i individuals gross earnings y_i with respect to the net-of-tax rate $1-\tau$. The elasticity ε_i is the elasticity of the number of type-i residents N_i with respect to the net-of-tax rate $1-\tau$. As described with more details in the text, ε_i is negative for all individuals who have an income level that is lower than the average income in the economy (break-even point). For the calibrations presented in the Table above, the migration responses to taxation are assumed to be constant across all earnings levels, that is to say of similar absolute value, meaning that all individuals in the population have the same migration response to an increase of their consumption through a change in taxes. The parameter e is the income weighted average labour supply elasticity $\sum_i((N_i y_i)/Y) \times e_i$ and the parameter $\bar{\varepsilon}$ is the combination of the income weighted and population weighted average mobility elasticity $\bar{\varepsilon} = \sum_i((N_i y_i)/Y) \times \varepsilon_i - \sum_i(N_i/N) \times \varepsilon_i$. The average welfare weight $\bar{g}$ captures the redistributive preferences of the government. The moderately redistributive government values the welfare of individuals in the bottom fifty percent two times more than the welfare of individuals in the other deciles with a corresponding $\bar{g} = 0.77$. The highly redistributive government values the welfare of individuals in the bottom fifty percent five times more than the welfare of other deciles with a corresponding $\bar{g} = 0.55$. The Ralwsian government only values the welfare of individuals in the bottom fifty percent. The welfare of each individual is computed using the utility specification $u_i = (1-\tau)y_i + T_0 - 1/(1+1/e_i) \times l_i^{1+1/e}$. Pre-tax earnings are endogeneously determined and follow the first order condition of the individual $y_i = w_i^{1+e}(1-\tau)^e$ using an exogeneous distribution of skills for w_i calibrated using the current distribution of French labour earnings combined with a current linear tax rate of 50 percent, displayed in Table D.2. The welfare effect of tax competition is the variation in percentage of individuals' welfare from a federal union to a competition union. A negative welfare variation means that individuals would be better off in a federal union.

Figure 4.1: **Distribution of Welfare Gains and Losses from Tax Competition with a Linear Tax Schedule**

Panel A. Moderately Redistributive Government



Panel B. Highly Redistributive Government



Notes: This graph shows the distribution of the welfare effects of tax competition across labour earnings' deciles. The welfare effect of tax competition is the variation in percentage of individuals' welfare from a federal union to a competition union. A negative welfare variation means that individuals would be better off in a federal union. The moderatively redistributive government values the welfare of individuals in the bottom fifty percent two times more than individuals in higher income deciles. The highly redistributive government values the welfare of individuals in the bottom fifty percent five times more than individuals in the higher deciles. The tax system consists in a linear τ paid on income and a universal demogrant redistributed to everyone. The parameter ε_i is the elasticity of migration with respect to the net-of-tax rate, while $\bar{\varepsilon}$ is a combination of income-weighted and population-weighted average migration elasticity. See the note below Table 4.1 for more details on the computation of the optimal tax rates and individuals' welfare.

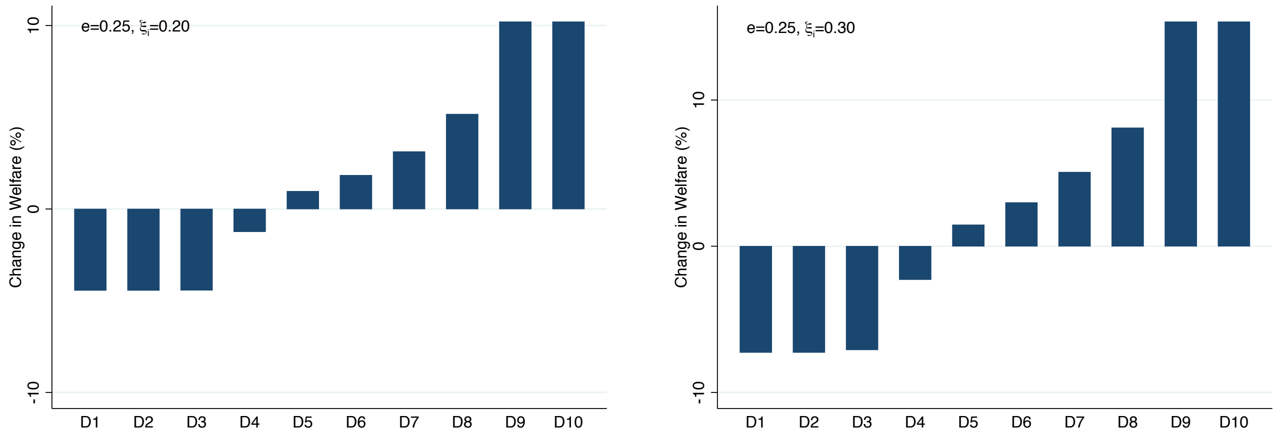
Table 4.2: **Effects of Tax Competition on Optimal Taxes and Welfare With a Non Linear Tax Schedule**

	Scenario 1 Elasticities e=0.25 ξ=0.1		Scenario 2 Elasticities e=0.25 ξ=0.2		Scenario 3 Elasticities e=0.25 ξ=0.3		Scenario 4 Elasticities e=0.25 ξ=0.4	
I- Average Marginal Tax Rates *(Marginal Tax Rate in the Top Bracket in Parentheses)*	Federal	Competition	Federal	Competition	Federal	Competition	Federal	Competition
Rawlsian	.69	.68	.69	.67	.69	.66	.69	.64
	(.64)	*(.63)*	*(.64)*	*(.61)*	*(.64)*	*(.59)*	*(.64)*	*(.55)*
Highly Redistributive	.62	.60	.62	.58	.62	.56	.62	.53
	(.57)	*(.54)*	*(.57)*	*(.51)*	*(.57)*	*(.48)*	*(.57)*	*(.45)*
Mod. Redistributive	.43	.41	.43	.39	.43	.37	.43	.35
	(.37)	*(.35)*	*(.37)*	*(.31)*	*(.37)*	*(.29)*	*(.37)*	*(.26)*
II- Welfare effect of Tax Competition (%)	Bottom 10	Bottom 50	Bottom 10	Bottom 50	Bottom 10	Bottom 50	Bottom 10	Bottom 50
Rawlsian	-.7	-.3	-.8	-.4	-2.9	-2.4	-4.8	-4.3
Highly Redistributive	-2.7	-2.1	-4.5	-3.4	-7.3	-5.9	-11.7	-9.5
Mod. Redistributive	-4.5	-3.4	-8.3	-5.0	-12.8	-9.3	-14.5	-11.5

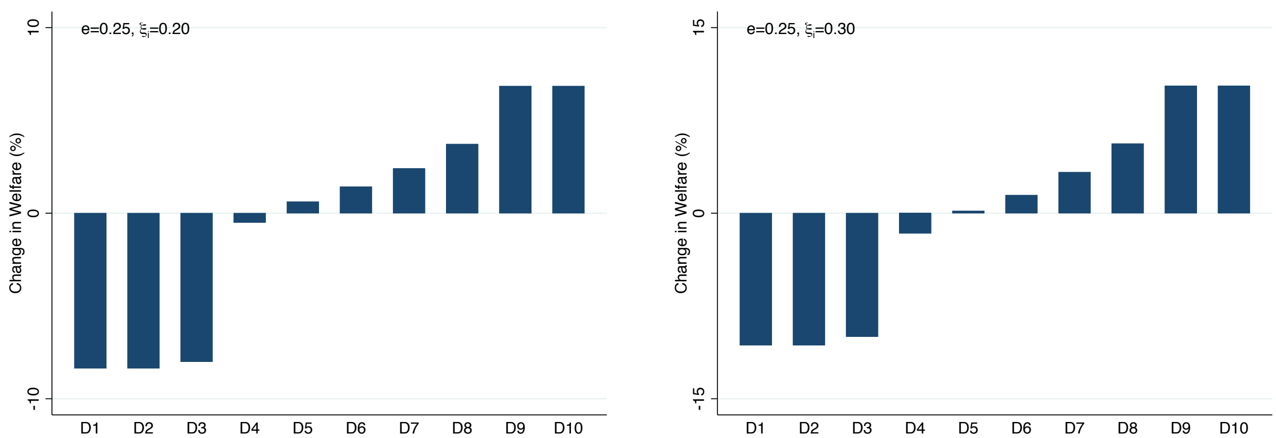
Notes: This Table summarizes the effects of tax competition on optimal tax rates and welfare. The optimal non linear tax rates are computed following the formulas presented with more details in the text and presented in Proposition 6 and Proposition 7. The numerical simulations use a discrete grid of earnings with eight income tax brackets taken from the empirical distribution of labour earnings in France and displayed in Table D.2. The elasticity of migration with respect to taxation ξ_i and the labour supply elasticity e_i are taken as constant across individuals and denoted ξ and e. The average marginal tax rates reports the average marginal tax rates across income tax brackets weighted by income in each bracket. The optimal marginal tax rates in the top income tax bracket are also reported in parentheses. The welfare is computed following Equation (4.8) and the endogeneous densities are determined following the functional form detailed in Equation (4.20). The moderately redistributive government corresponds to a government that values the welfare of individuals in the bottom fifty percent two times more than the welfare of individuals in higher earnings' deciles. The highly redistributive government values the welfare of individuals in the bottom fifty percent five times more than the welfare of individuals in higher income deciles. The welfare effect of tax competition is the variation in percentage of individuals' welfare from a federal union to a competition union. A negative welfare variation means that individuals would be better off in a federal union.

Figure 4.2: **Distribution of Welfare Gains and Losses from Tax Competition with a Non-Linear Tax Schedule**

Panel A. Highly Redistributive Goverment



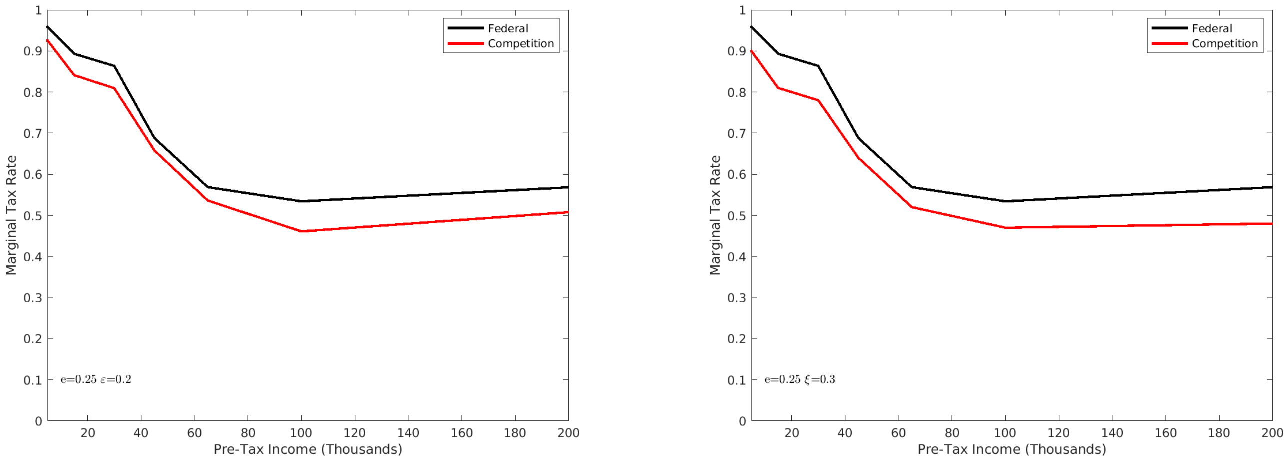
Panel B. Moderately Redistributive Government



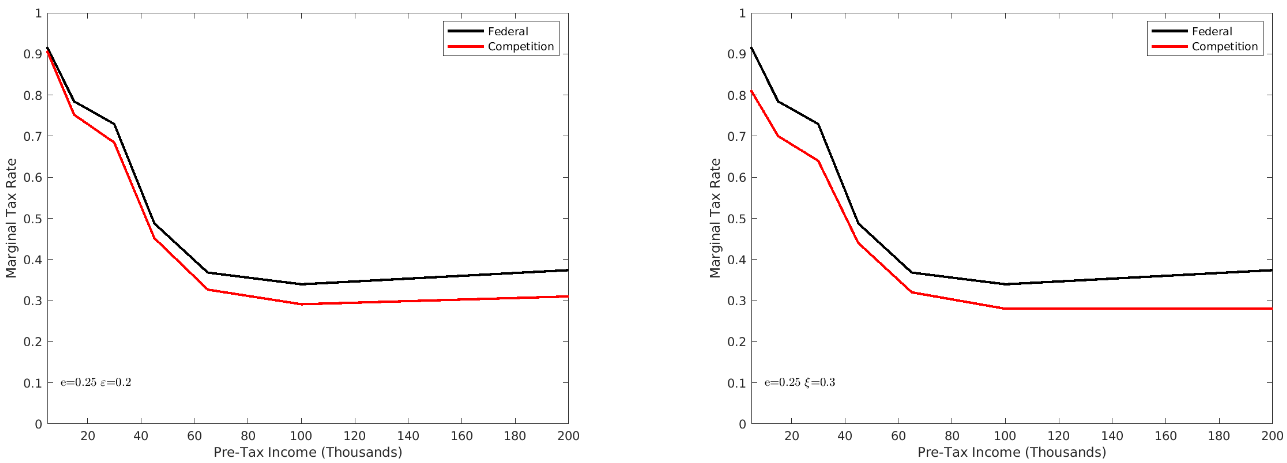
Notes: This graph shows the distribution of the welfare effects of tax competition across labour earnings' deciles. The welfare effect of tax competition is the variation in percentage of individuals' welfare from a federal union to a competition union. A negative welfare variation means that individuals would be better off in a federal union. The moderatively redistributive government values the welfare of individuals in the bottom fifty percent two times more than individuals in higher income deciles. The highly redistributive government values the welfare of individuals in the bottom fifty percent five times more than individuals in the higher deciles. The tax system is non linear. The parameter ξ_i is the elasticity of migration with respect to the disposable income, and is taken as constant across earnings' deciles. See the note below Table 4.2 for more details on the computation of the optimal tax rates and individuals' welfare.

Figure 4.3: **Optimal Non-Linear Tax Schedules**

Panel A. Highly Redistributive Goverment



Panel B. Moderately Redistributive Government



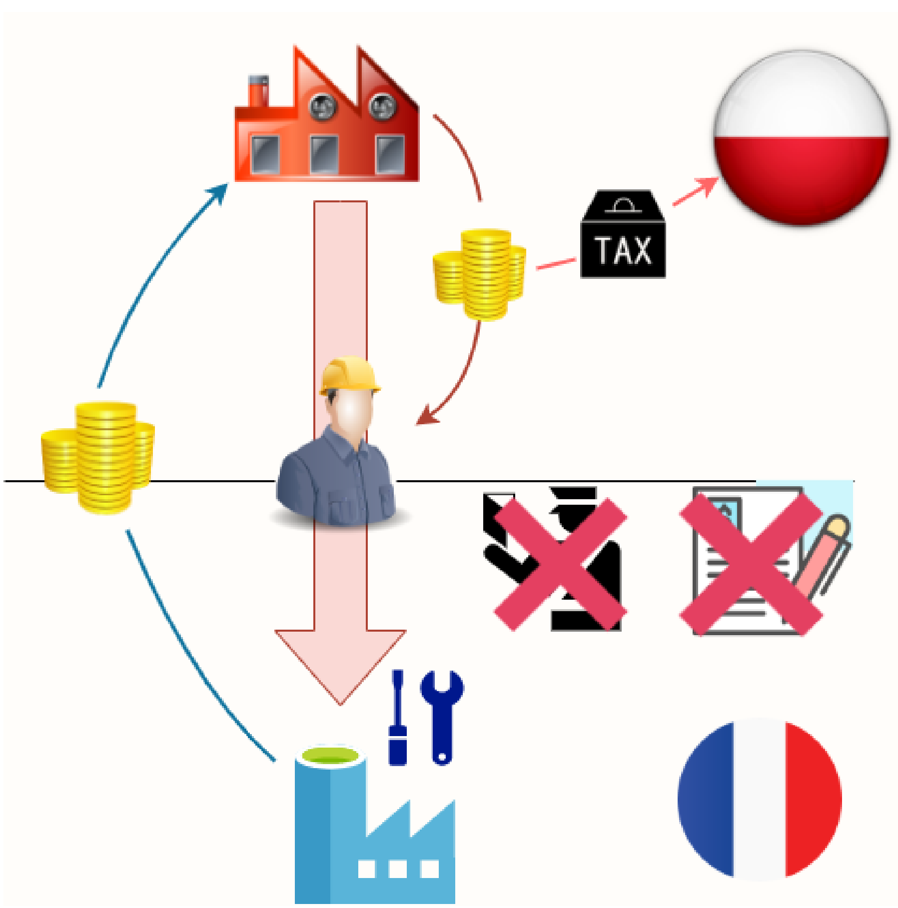
Notes: This Figure shows the optimal marginal tax rates schedule after the numerical simulations of Proposition 5 and Proposition 6.

Appendix A

Trading Non-Tradables: The Implications of Europe's Job Posting Policy

A.1 Additional Figures and Tables

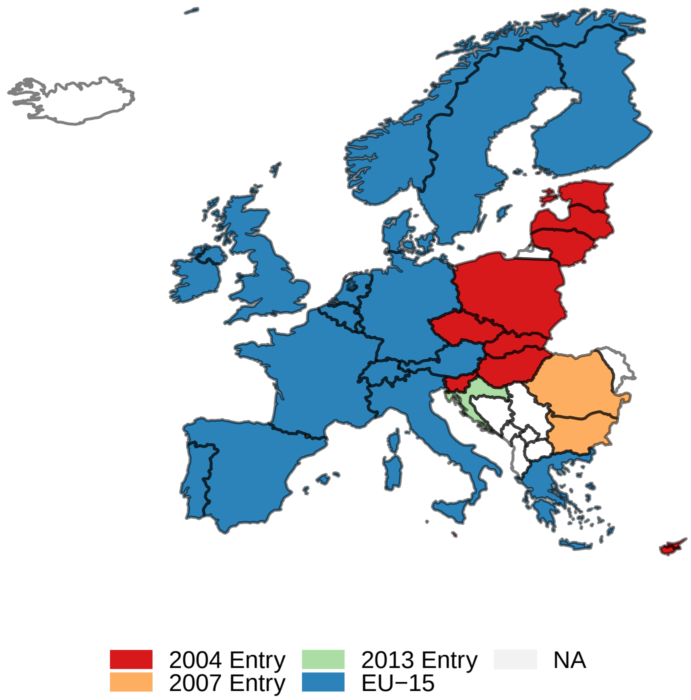
Figure A.1: **Non-Tradable Services Export from Poland (PL) to Germany (DE)**



Notes: This diagram summarizes the European posting policy that allows firms established in one member state to send their workers

Figure A.2: **Timing of Posting Liberalization**

A. Three Waves of EU Accession Events

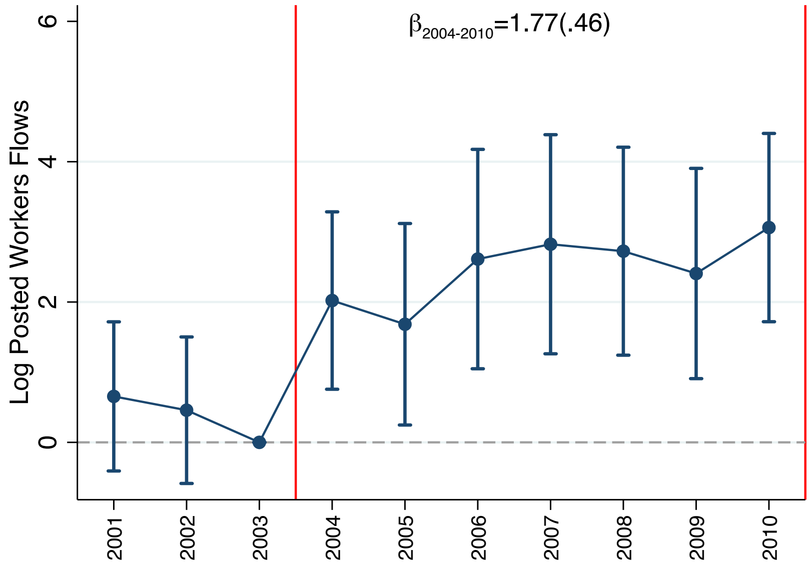


B. Staggered Timing Across Origin-Destination Set by the EC

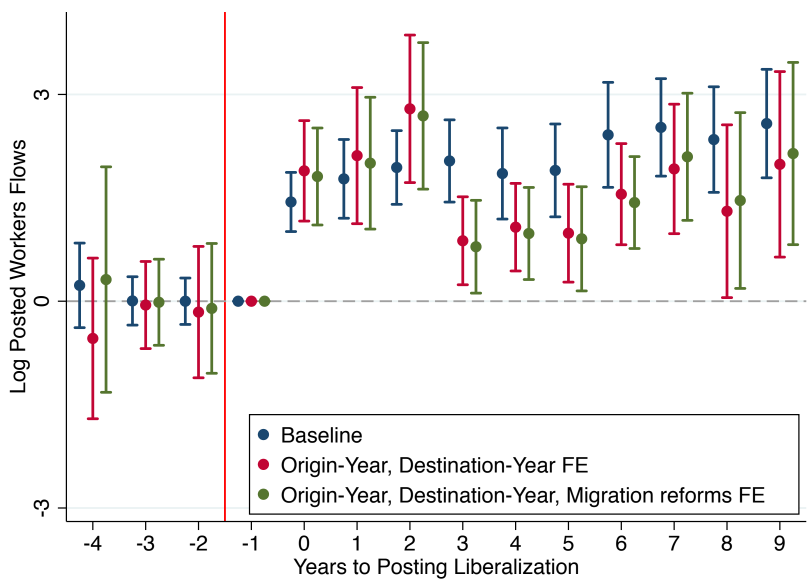
Notes: This Figure shows the timing of EU accession for new member states (NMS) located in Eastern European countries from 2004 to 2013. The EU enlargements of 2004, 2007 and 2013 trigerred posting liberalization for successively 10 (Poland, Lithuania, Hungary, Estonia, Latvia, Slovakia, Slovenia, Czech Republic, Malta and Cyprus), 2 (Bulgaria and Romania) and 1 (Croatia) countries located in Eastern Europe. The bottom figure summarizes the differential timing posting mobility liberalization for some country pairs. Before EU accession, employees sent from these new member states to an EU member state had to request a work and entry authorization in the destination country. As detailed in the text, all destination countries lifted posting mobility restrictions at EU accession, while Germany and Austria were allowed by the European Commission to keep pre-existing entry barriers for 7 additional years following each EU accession events. After the lifting of mobility restrictions, destination countries have no right to refuse the foreign intervention performed by another EU member state in their territory.

Figure A.3: **Robustness to Excluding Migration and Posting Reform Events**

A. Robustness to Excluding Simultaneous Migration and Posting Reform Events



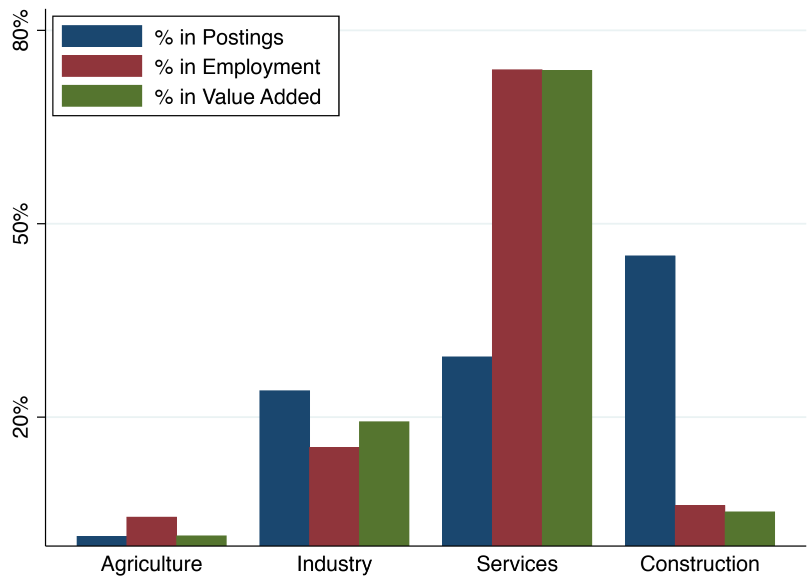
B. Robustness to Controlling for Bilateral Migration Reforms



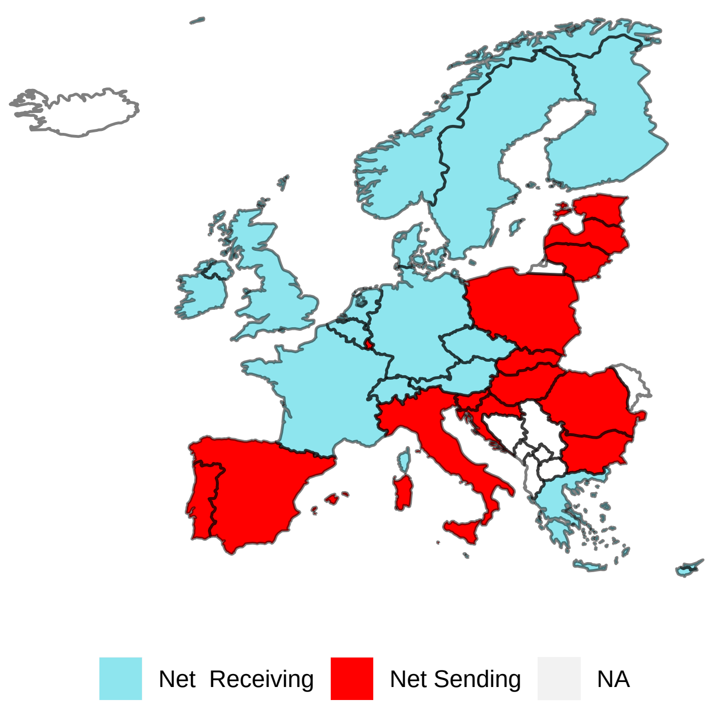
Notes: The Figure shows the effects of an origin-specific posting liberalization shocks on posted workers flows to France. In 2004, posting restrictions for countries that became EU members in 2004 (NMS 2004: Poland, Lithuania, Latvia, Estonia, Slovakia, Slovenia, Hungary, Czech Republic, Malta and Cyprus) were lifted. Posting restrictions for workers posted from NMS2004 were kept until 2011 in the German construction sector. In a triple differences design, Panel B compares the differential evolution of postings from countries treated and not treated by the 2004 enlargement, to France versus Germany where NMS 2004 were not granted the end of posting restrictions, controlling for destination and origin-year fixed effects. Figure B repeats the baseline estimation Equation (1.1) adding as a control a dummy for bilateral migration reforms occuring at different timings than posting liberalization reforms.

Figure A.4: **Posting Flows in Europe: Geography and Sectors**

A. Overall Economic Activity and Postings Within EU



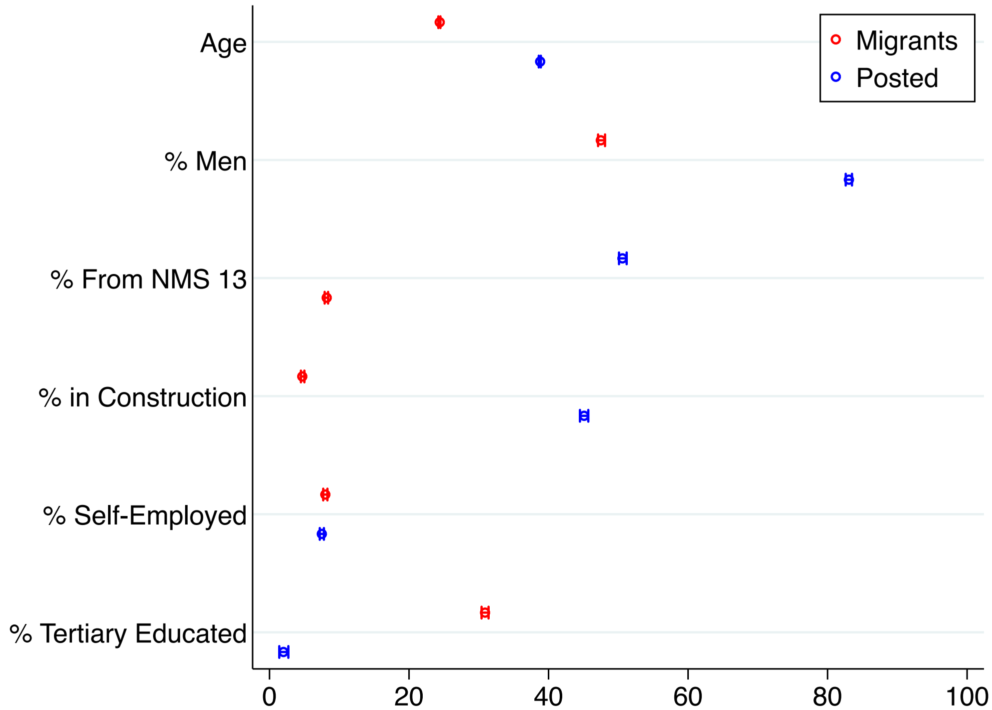
B. Exporters and Importers of Posting Services



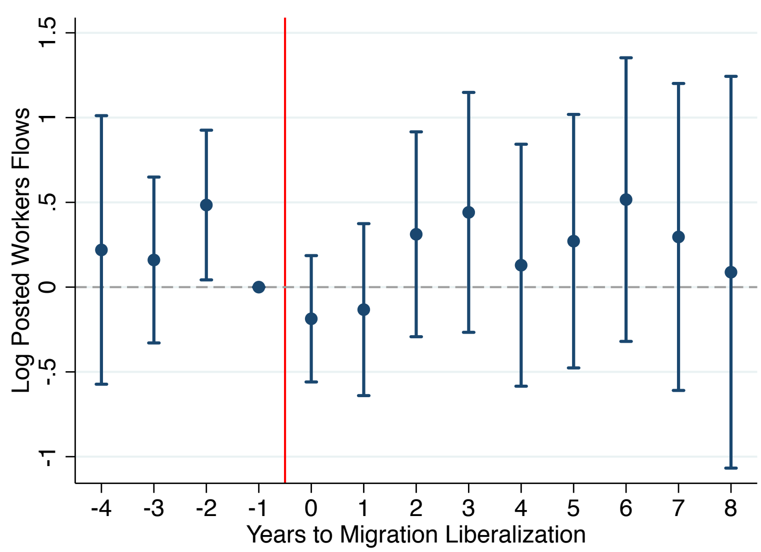
Notes: The Figure A shows the sectoral decomposition of posting missions within the EU as well as the share of European value added and employment of each of these sectors. The Figure is based on mandatory social security forms E101/A1 that foreign employees must hold when they provide a service in another EU member state, this dataset is described in Appendix. Statistics from EU-level employment and value added are from Eurostat economic indicators. Figure B shows the location of consumers and providers of cross-border services performed through posting in Europe. Net sending countries (in red) are countries that performed more services in the EU by sending workers abroad compared to the number of services performed by workers posted to their territory. Net receiving countries (in blue) are countries that consumed more services performed by foreign workers posted to their territory compared to the number of services their domestic workers performed abroad.

Figure A.5: **Complementarity of Migration and Posting**

A. Posted Workers Differ From Standard Migrants



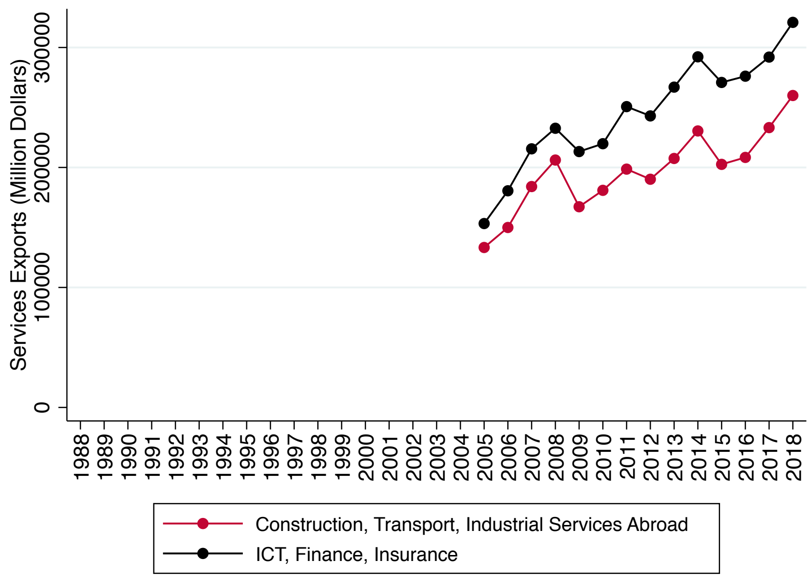
B. Posting Flows Do Not React to Standard Migration Liberalization



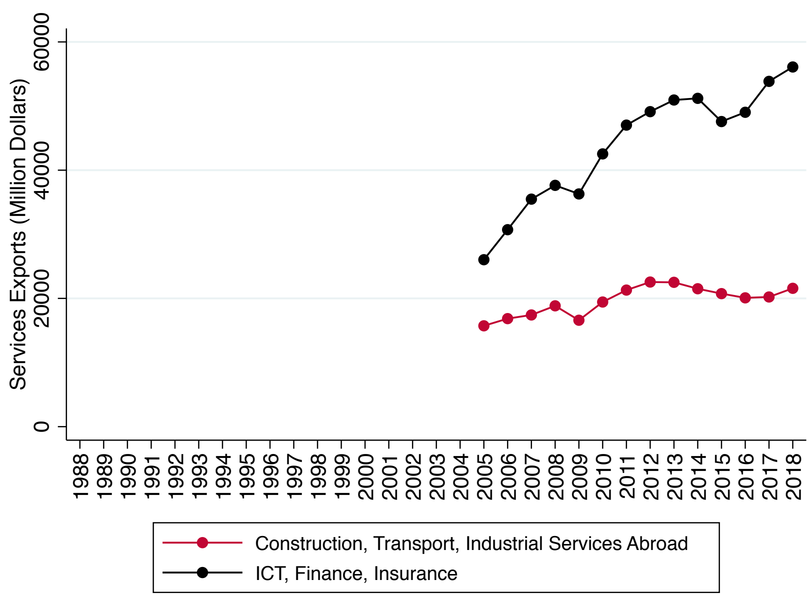
Notes: The figure illustrates potential complementarity or substitution between standard migration and posting. Figure A shows demographics of posted workers versus standard migrants for the second and third importer of posting services in Europe: France and Belgium. In 2019, 227,991 unique posted workers were in France and 269,235 to Belgium. For posted workers, being tertiary educated is proxied by having a managerial job, and this information is only available for workers posted to France. Self-employed posted workers are only recorded in Belgium. Demographics for migrants come from the EU-LFS dataset, a continent-wide European survey. Migrants are defined as working-age foreigners who live permanently in France or Belgium. For posted workers, all demographics are measured in the year of the posting mission. For migrants, all characteristics are measured at the time of the survey, but age is the age at which they arrived in the destination country. NMS 13 refers to the 13 new member states that entered in the EU since 2004 and are located in Eastern Europe (figure A.2). Figure B estimates posting flows reponses to a change in standard migration reforms, when posting and standard migration are liberalized in different years.

Figure A.6: **International Exposure of Non-Tradable Sectors: EU vs NAFTA**

A. Within-EU service trade

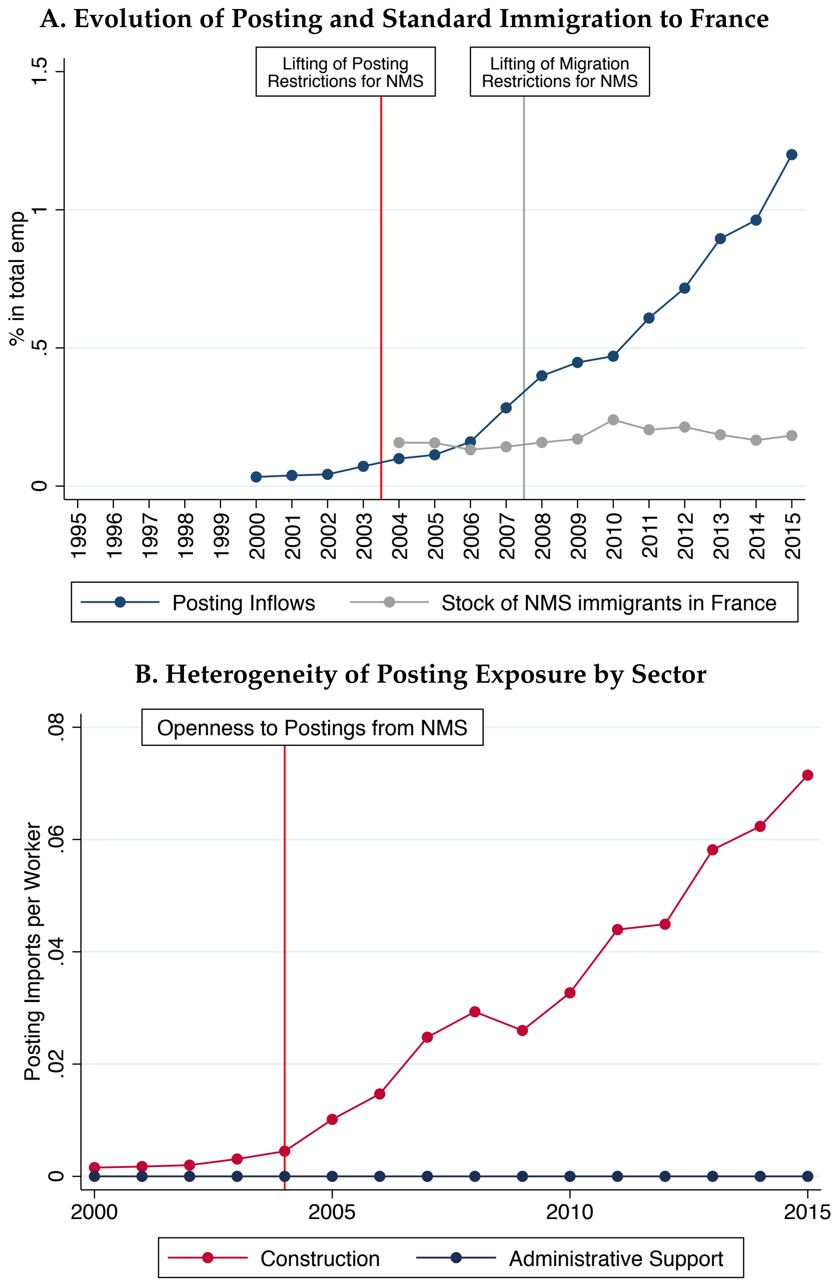


B. Within-NAFTA service trade



Notes: This figure compares non-tradable service trade within the EU and within the NAFTA since 2005. The figure is based on international data on service trade from the WTO for 12 sectors. I select sectors where trade is purely mobility dependent, e.g., services that must be produced locally: construction, transport, and manufacturing services performed on inputs owned by others. To measure trade in services in sectors that are less mobility dependent, I select sectors where services can be produced remotely and exchanged easily through electronic means: information and communications technology (ICT), finance, and insurance. This measure of provision of services through posted workers is a lower bound of mobility-dependent trade, as services in ICT, finance, and insurance can also be performed through posted workers.

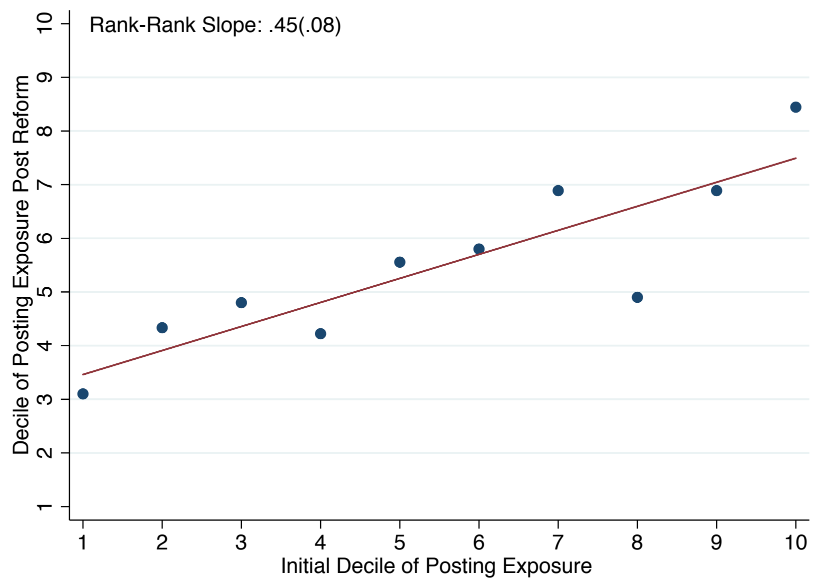
Figure A.7: **Posting of Workers to France Before and After the Liberalization Shock**



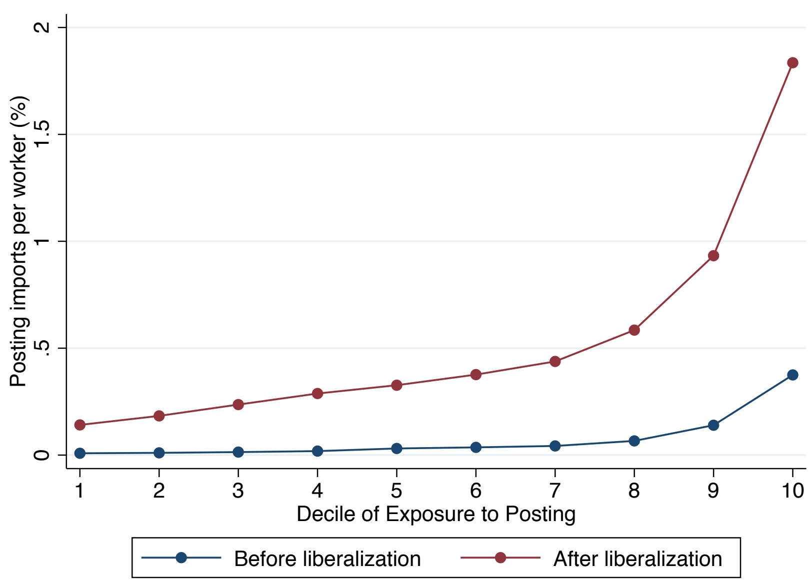
Notes: The Figure shows the evolution of exposed employment in provinces more or less close in terms of geographic distance to NMS countries that gain access to free posting in 2004.

Figure A.8: **Relationship Between Pre-Existing and Future Exposure to Posting Imports**

Panel A. Rank-Rank Correlation of Initial and Post-Liberalization Exposure

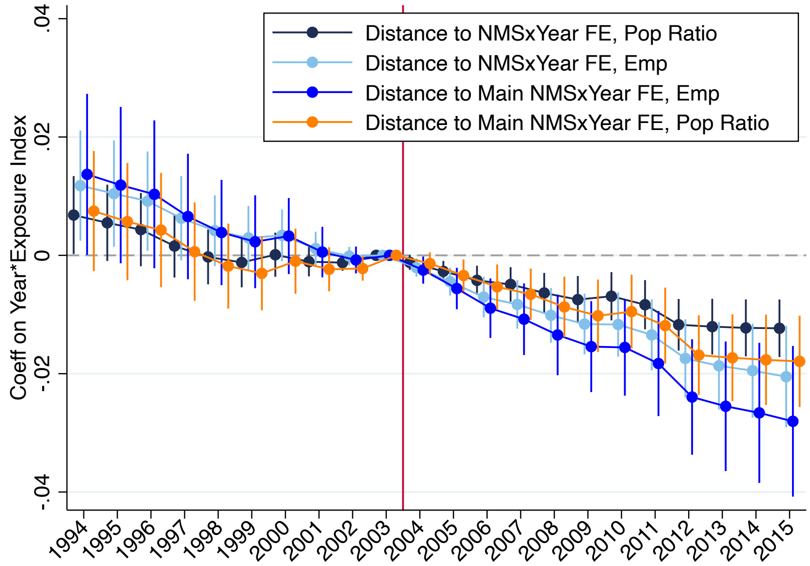


Panel B. Change in Imports by Initial Level of Exposure



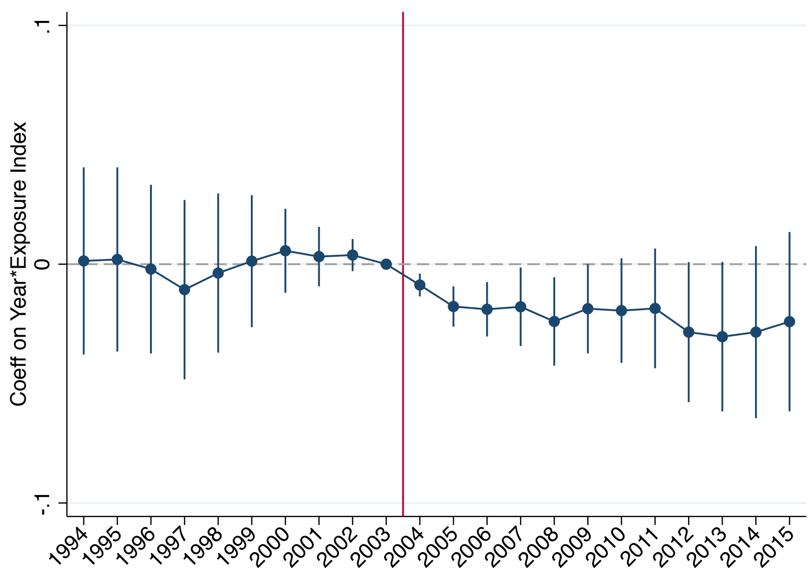
Notes: The Figure shows the correlation between the decile of exposure before the liberalization of posting services (x axis) and in years 2005-2015 following the reform. Posting exposure is defined as imported posting services per total worker in a province.

Figure A.9: **Alternative Exposure: Geographic Distance to NMS**



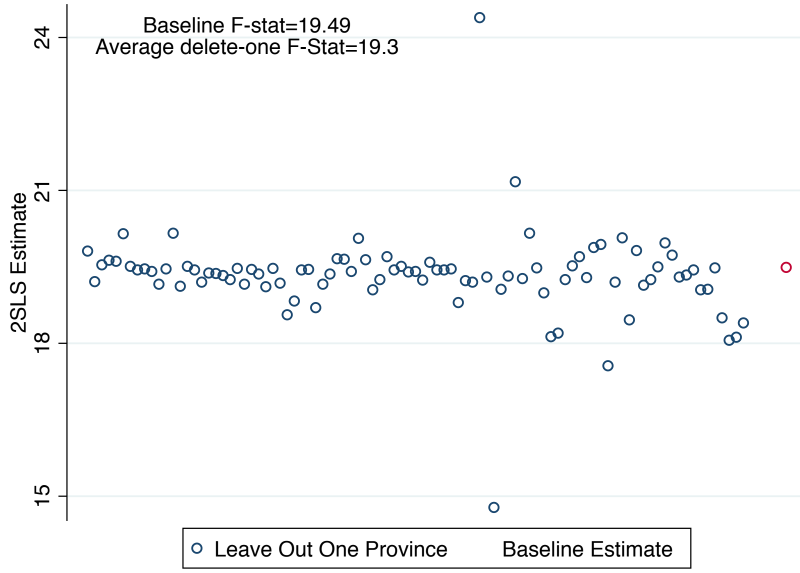
Notes: The Figure shows the evolution of exposed employment in provinces more or less close in terms of geographic distance to NMS countries that gain access to free posting in 2004.

Figure A.10: **Total Employment by Initial Exposure to Posting**



Notes: The Figure shows the correlation between the decile of exposure before the liberalization of posting services (x axis) and in years 2005-2015 following the reform. Posting exposure is defined as imported posting services per total worker in a province.

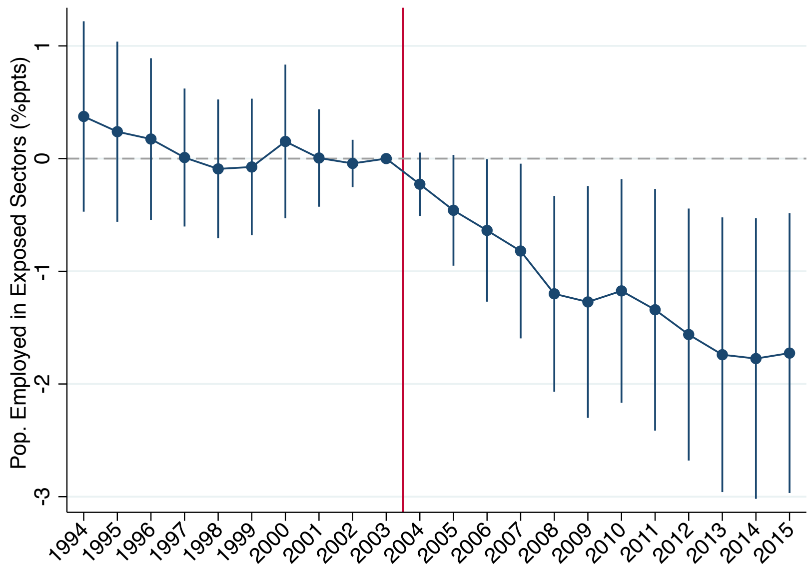
Figure A.11: **2SLS First Stage to "Delete-One" Test**



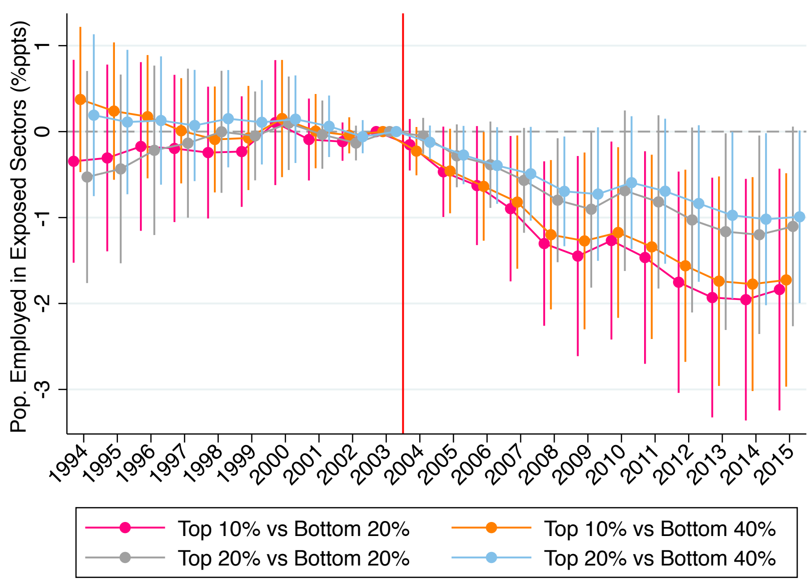
Notes: The Figure shows the robustness of the baseline first stage F statistics presented in Table A.6, column (1), to excluding each of the province (observation) from the baseline regression.

Figure A.12: **Causal Effect of the Posting Liberalization on Domestic Employment**

A. Dynamic Difference-in-Differences



B. Heterogeneity by Intensity of Local Labor Market Exposure



Notes: The figure displays the estimates from Equation (1.5) that capture the differential evolution of domestic employment in French provinces initially exposed to the liberalization of the posting policy. Panel A compares the evolution of domestic employment in provinces in the top 10% of pre-reform spatial exposure compared to provinces in the bottom 40% as control group, following the aggregate series displayed in Figure 1.7. The dependent variable is the share of a province working age population employed in exposed sectors, in percentage points. The event is the lifiting of posting restrictions for services supplied by low-cost countries in 2004-2005. The coefficient of the year before the reform ζ_{2003} is normalized to zero. The regression includes calendar year and province fixed effects. ζ_k compares employment in sectors exposed to the posting shock in provinces with high exposure to the reform in calendar year k, compared to employment in provinces with low exposure to the reform. The vertical line represents 95% confidence intervals computed from robust standard errors clustered at the province level. Panel B repeats the estimation using alternative definitions of high and low exposure to the shock, exemplifying the heterogeneities in employment effects depending on the intensity of local labor market exposure to the shock.

Figure A.13: **Additional Controls and Specifications**

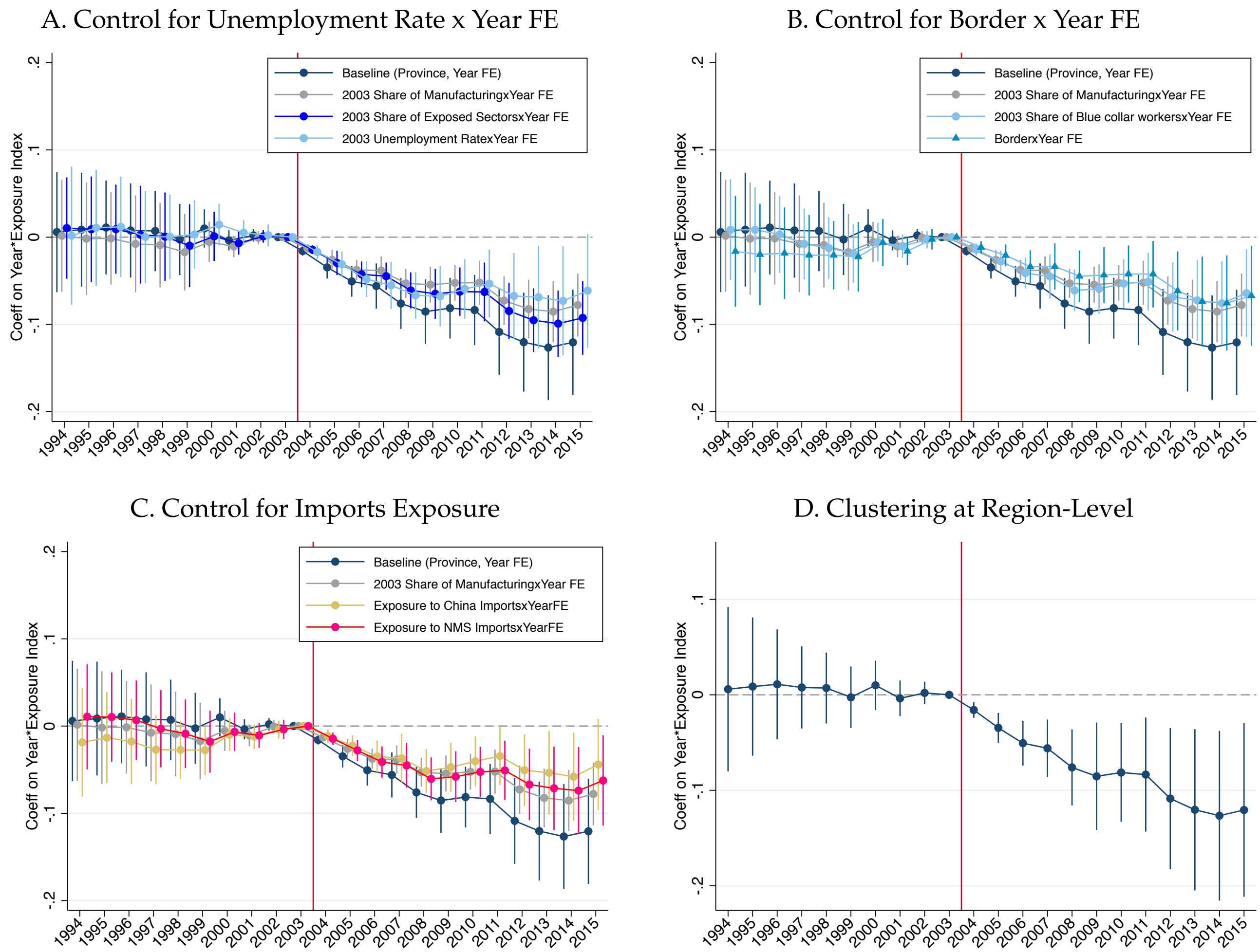
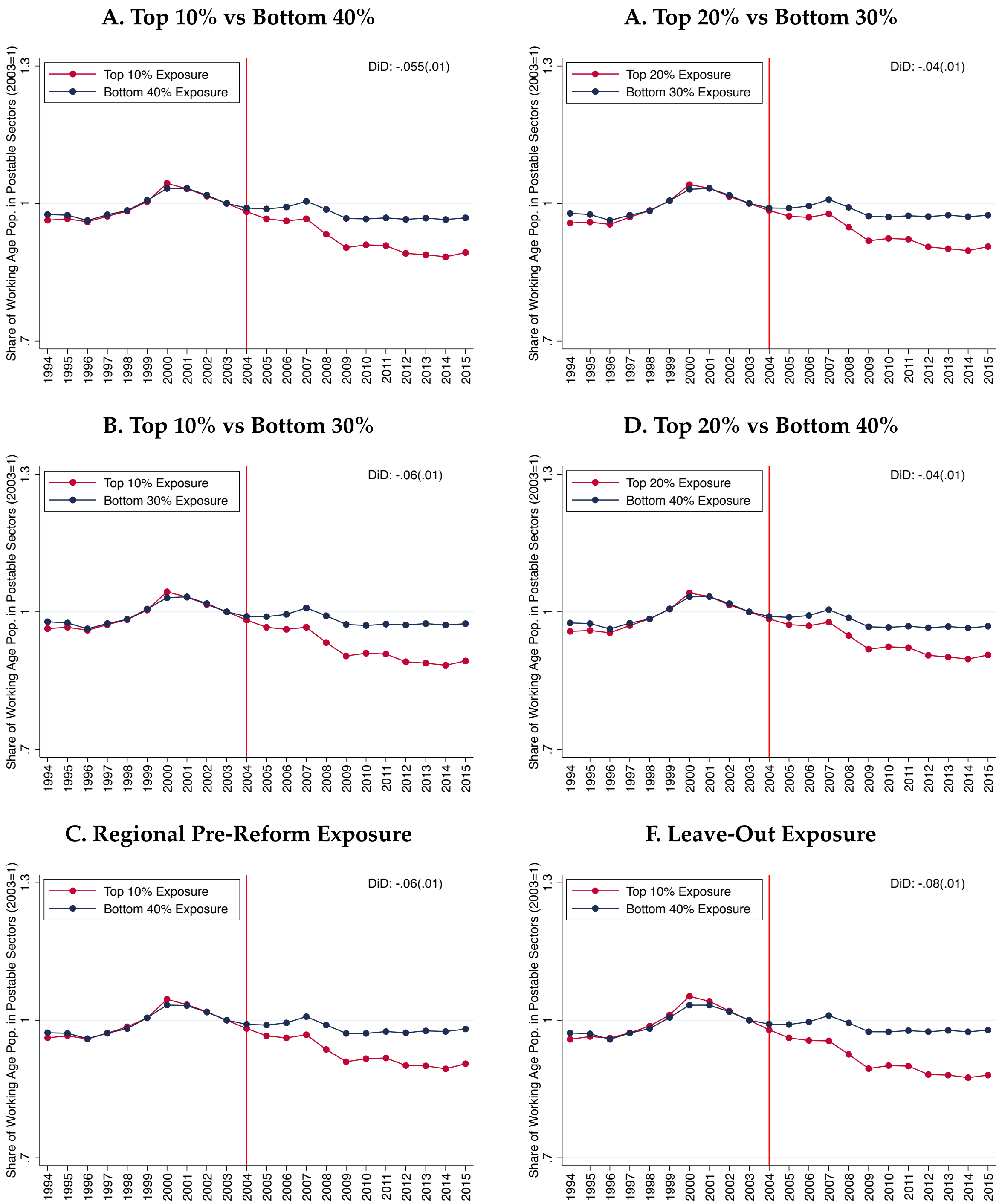


Figure A.14: **Robustness to Baseline DiD**



Notes: The figure repeats the baseline analysis presented in figure 1.7 with alternative thresholds to select top and bottom exposure provinces.

Figure A.15: **Alternative: Exposure to NMS2007 Shock**

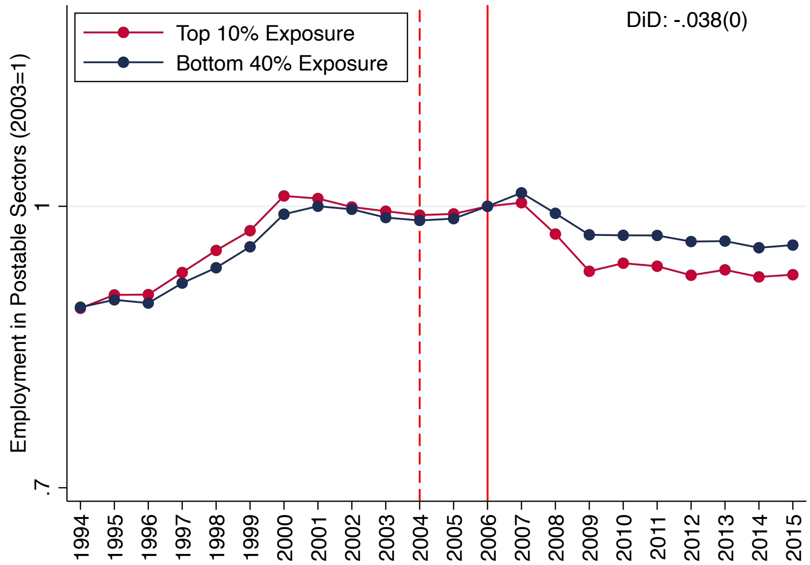
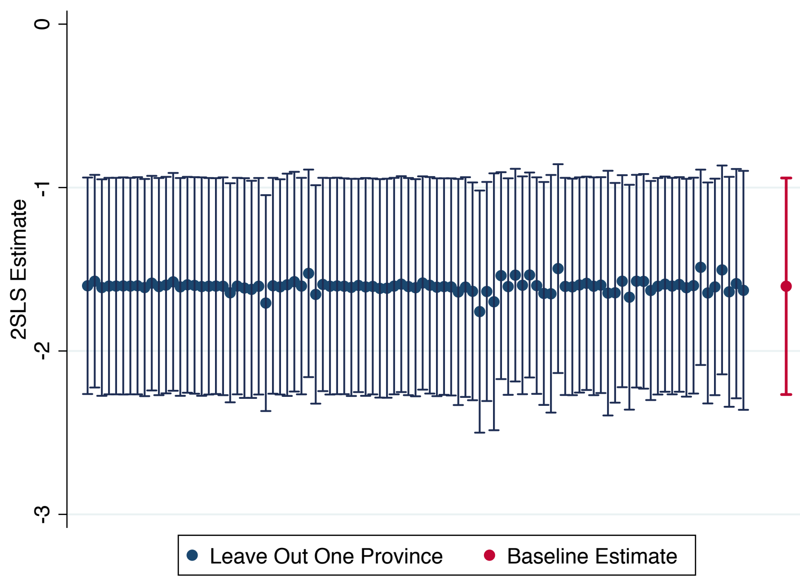
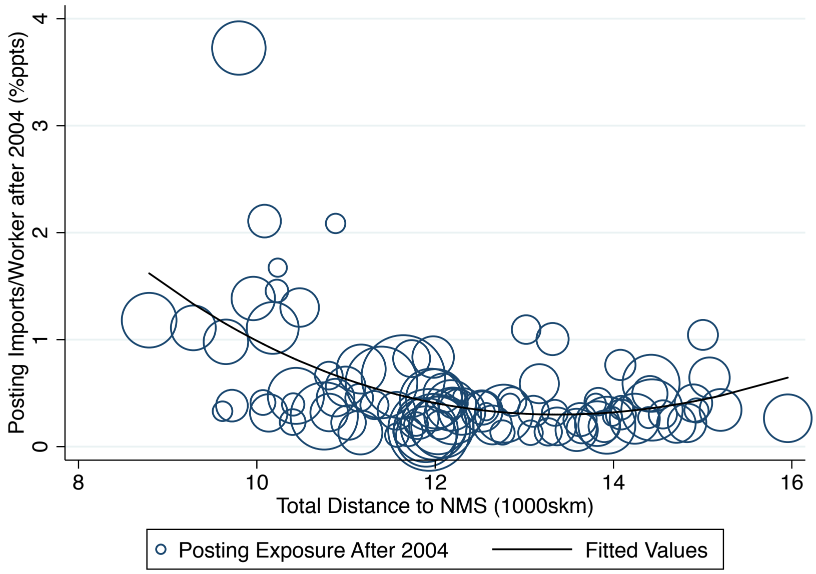


Figure A.16: **2SLS Robustness to "Delete-One" Test**



Notes: The Figure shows the robustness of the baseline 2SLS result presented in Table 1.3, column (2), to excluding each of the province (observation) from the baseline regression.

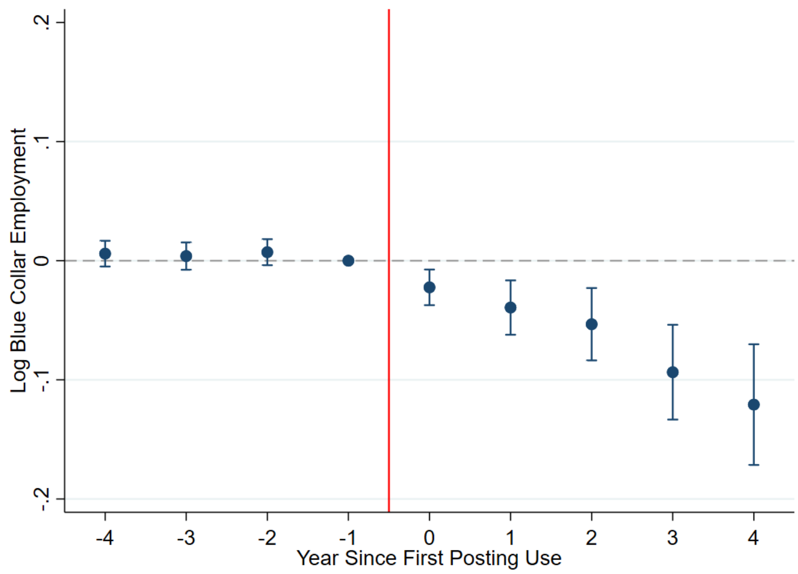
Figure A.17: **Geographic Distance to NMS Countries And Posting Imports After 2004**



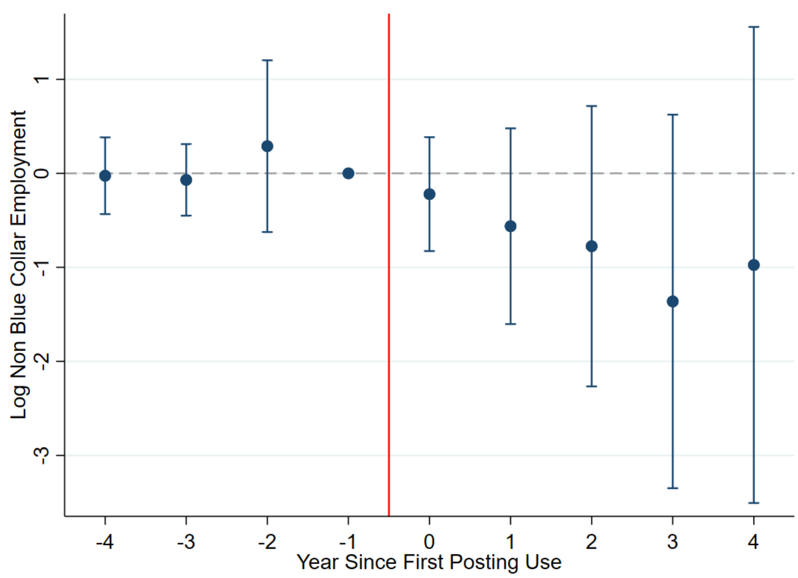
Notes: The Figure shows the correlation between a province imports of posting services per worker after 2004, and its geographic distance to NMS countries that gain the right to supply services in France after 2004. Geographic distance is computed as the sum of air distance of each province to each of the NMS countries. Observations are weighted by pre-liberalization population and the fitted values are computed with a quadratic term.

Figure A.18: **Firm-Level Displacement: Heterogenous Workers Exposure Within-Firm**

A. Blue Collar Employment at Receiving Firms



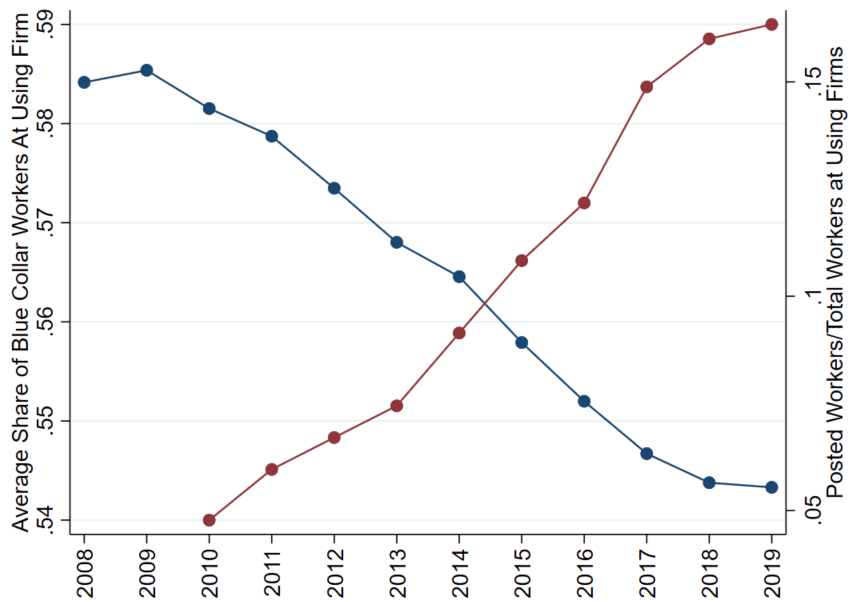
B. Other Employment At Receiving Firms



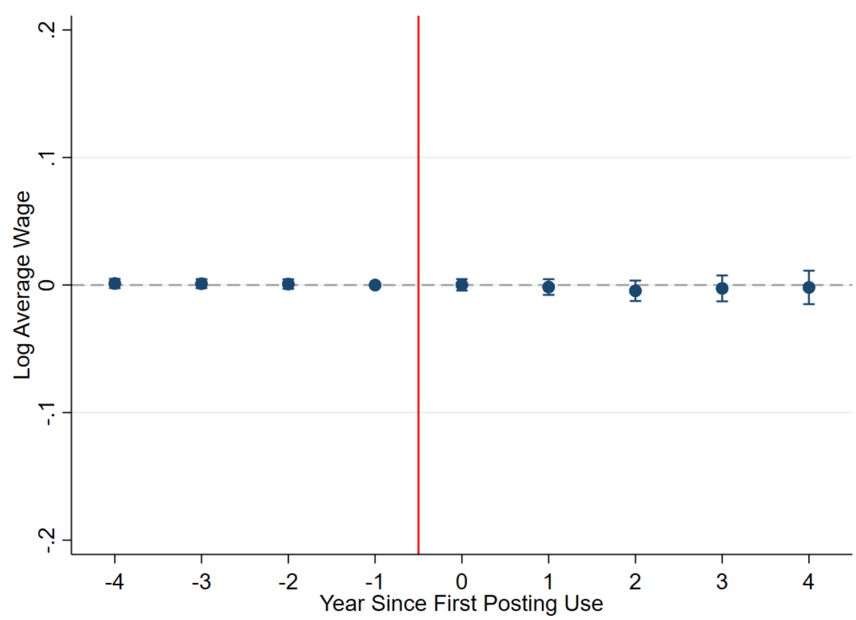
Notes: This figure uses exhaustive administrative posting records of Belgian firms merged with administrative employment data to select the 11,796 firms that started using posted workers for the first time between 2014 and 2019. The figure plots the estimated event study coefficients γ_k from Equation (1.8) for the period 2008-2019, where the dependent variable is log blue collar employment (Panel A) and log employment of other workers (Panel B). The event is defined as the first time a Belgian firm sources services to foreign posted employees. The coefficient of the year before the first posting use γ_{-1} is normalized to zero. The regressions include firm and three-digit sector $\times$ calendar year. γ_k compares the outcomes of receiving firms in event year k to the outcomes of future posting firms in the same narrowly defined sector in the year before their event. The vertical line represents 95% confidence intervals computed from robust standard errors clustered at the calendar year $\times$ province level.

Figure A.19: **Additional Results on Receiving Firms Responses to Posting**

A. Aggregate Domestic Blue Collar Employment and Exposure to Posting Flows



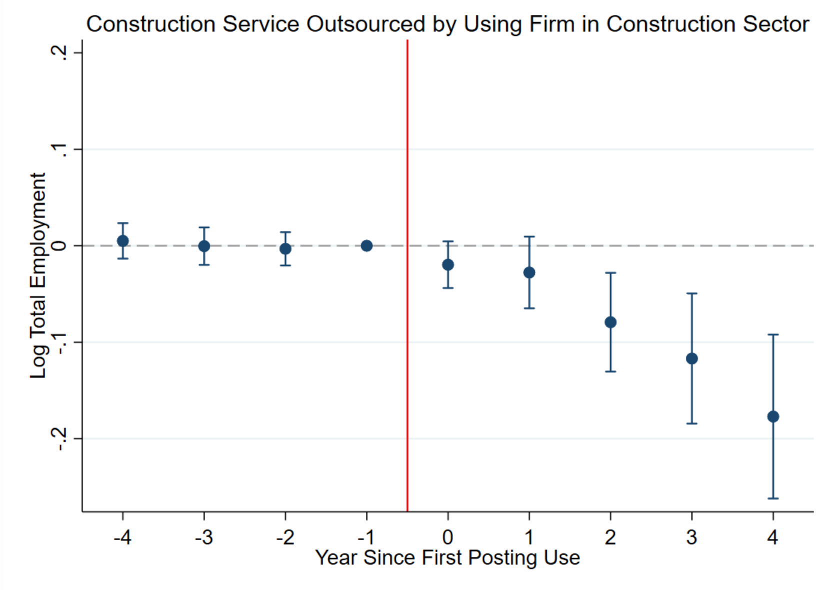
B. Receiving-Firm Level Wage Rate After Using Posted Workers



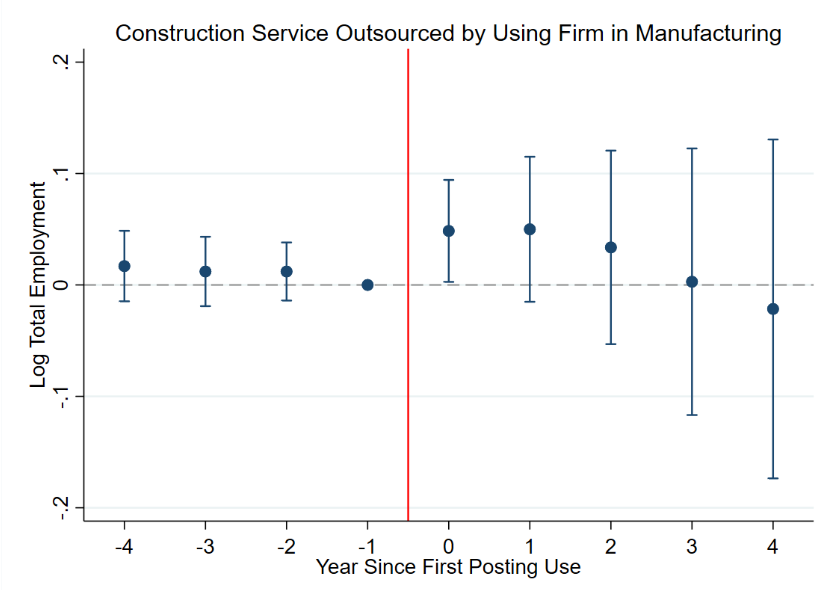
Notes: Figure A uses exhaustive administrative posting records of Belgian firms merged with administrative employment data to observe the 23,380 Belgian firms that purchased a posting service at some point between 2010 and 2019. For these firms, the graph displays the evolution of the share of domestic blue collar workers in total employment (blue line, left axis) and the evolution of posted workers in total employment (red line, right axis). Figure B plots the estimated event study coefficients γ_k from Equation (1.8) for the period 2008-2019, where the dependent variable is log wage. The event is defined as the first time a Belgian firm sources services to foreign posted employees. The coefficient of the year before the first posting use γ_{-1} is normalized to zero. The regressions include firm and three-digit sector $\times$ calendar year. γ_k compares the outcomes of receiving firms in event year k to the outcomes of future posting firms in the same narrowly defined sector in the year before their event. The vertical line represents 95% confidence intervals computed from robust standard errors clustered at the calendar year $\times$ province level.

Figure A.20: **Firm-Level Displacement: Heterogenous Workers Exposure Across-Firm**

A. Posted Workers Performing Same Tasks than Domestic Workers



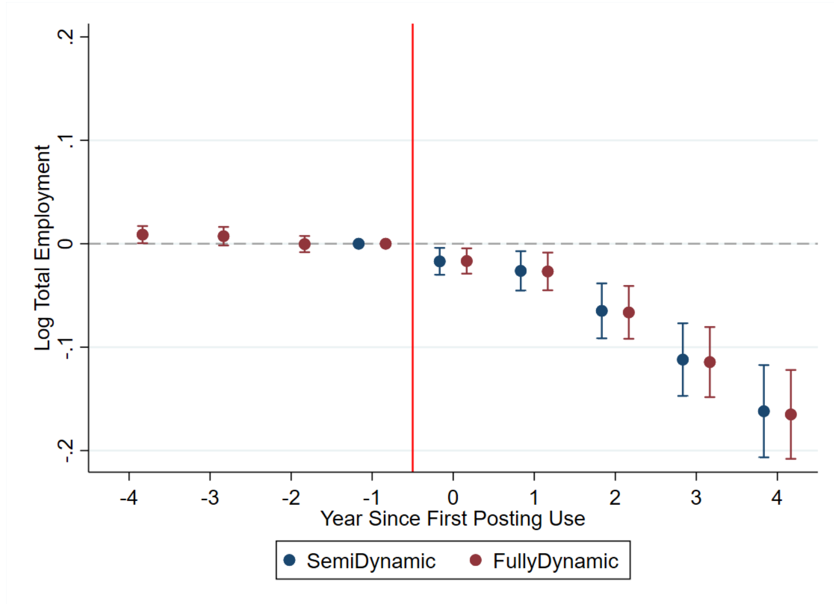
B. Posted Workers Performing Different Tasks than Domestic Workers



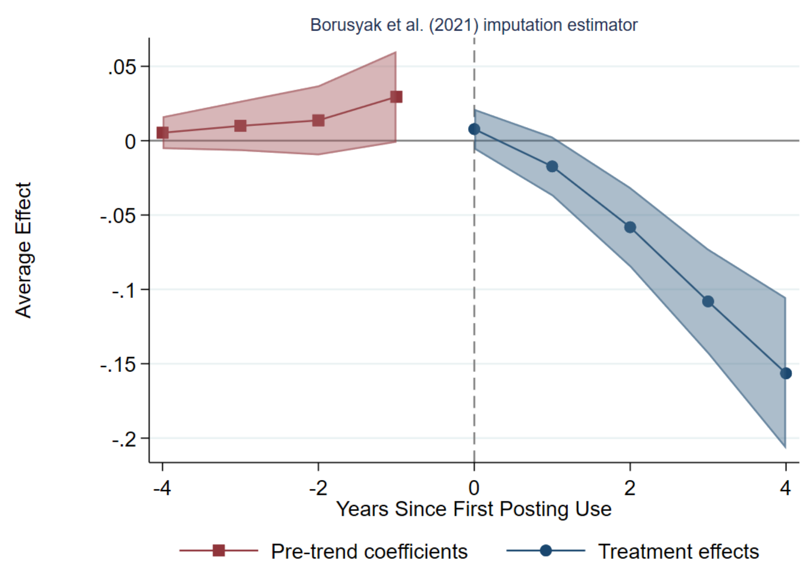
Notes: This figure uses exhaustive administrative posting records of Belgian firms merged with administrative employment data to select the 11,796 firms that started using posted workers for the first time between 2014 and 2019. The figure plots the estimated event study coefficients γ_k from Equation (1.8) for the period 2008-2019, where the dependent variable is log employment. The event is defined as the first time a Belgian firm sources services to foreign posted employees. The coefficient of the year before the first posting use γ_{-1} is normalized to zero. The regressions include firm and three-digit sector $\times$ calendar year. γ_k compares the outcomes of receiving firms in event year k to the outcomes of future posting firms in the same narrowly defined sector in the year before their event. The vertical line represents 95% confidence intervals computed from robust standard errors clustered at the calendar year $\times$ province level. Panel A focuses on the sample of Belgian clients that purchase a posting service in the same sector of activity than the one performed by their own domestic workers. Panel B focuses on Belgian firms that purchase a posting service in a sector of activity that is different than the main activity performed by domestic workers (a manufacturing firm purchasing a construction service).

Figure A.21: **Firm-Level Displacement Effects: Alternative Specifications**

A. Fully and Semi-Dynamic OLS Estimation



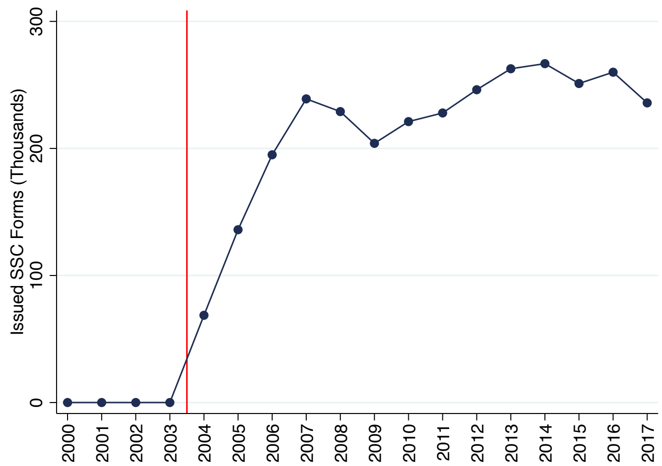
B. Estimates Accouting for Heterogeneous Treatment Effects



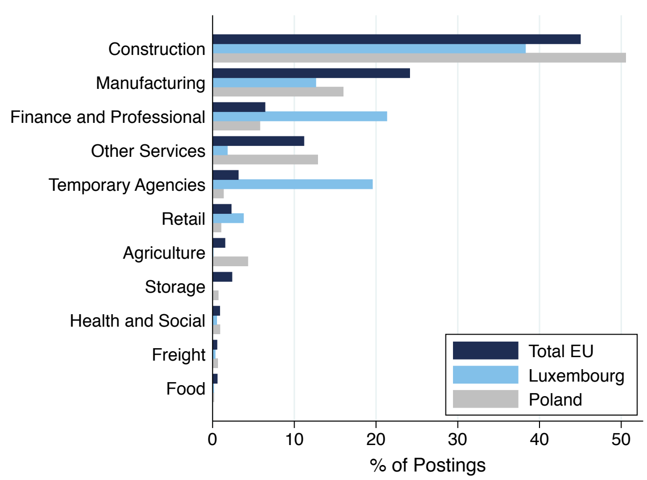
Notes: This figure uses exhaustive administrative posting records of Belgian firms merged with administrative employment data to select the 11,796 firms that started using posted workers for the first time between 2014 and 2019. The figure plots the estimated event study coefficients γ_k from Equation (1.8), investigating robustness to semi-dynamic specification (Panel A) and using an alternative estimator developed by **?** that accounts for heterogeneous treatment effects (Panel B).

Figure A.22: **Effects of the Liberalization Reform on Postings From Poland**

A. Postings from Poland Post-2004



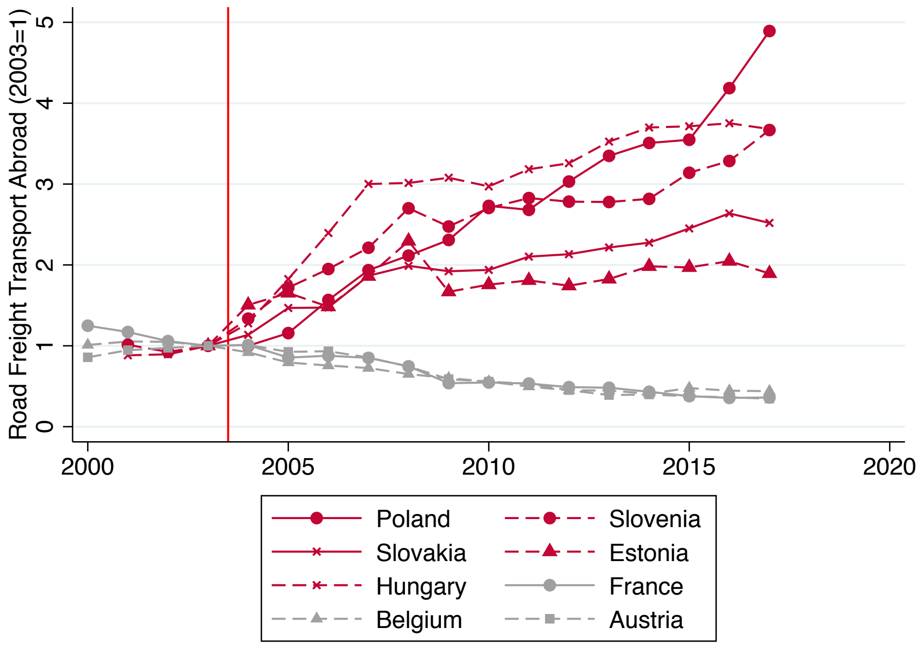
C. Sectors of Services Supplied Through Posting



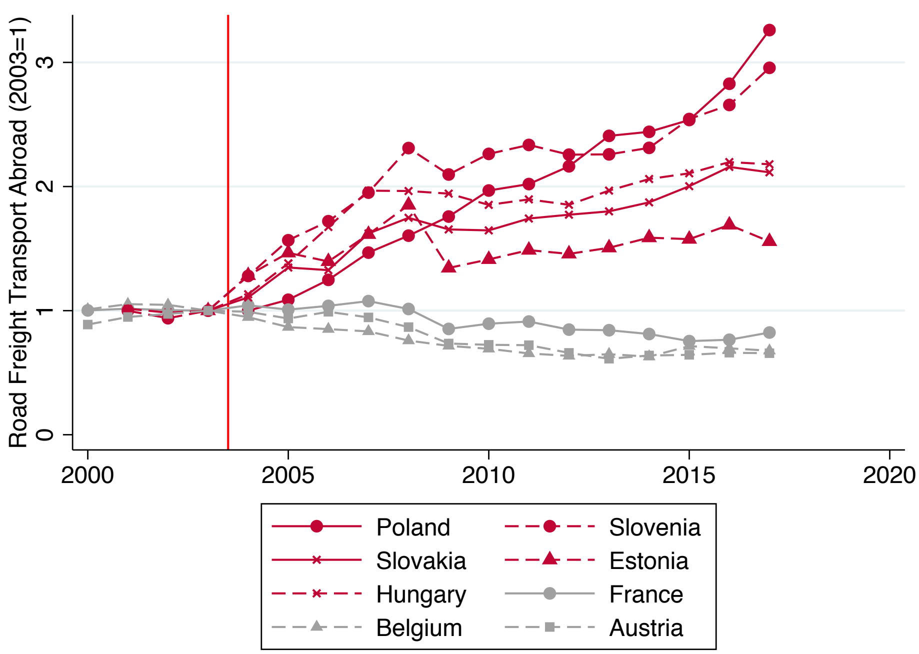
Notes: This figure shows the aggregate employment effects of posting openness for Poland, the first supplier of posting services since 2005. Poland became a EU member state in 2004. That year, all mobility restrictions for employees posted by Polish suppliers were lifted, except for postings from Poland to Austria and Germany that were deregulated in 2011 (the first-stage effects of these mobility reforms are analyzed in Figure 1.4). Panel A shows the effect of the 2004 service trade liberalization on E101/A1 mandatory posting forms issued by Poland. As described in the paper, E101/A1 forms are only measured for EU member states and are zero by construction for Poland before 2004. Panel B shows the heterogeneous exposure to the posting openness shock across sectors. Most of the postings from Poland occur in the construction sector, while regulated sectors like health, education, or public administration are covered by licensing regulations that prevent them from being performed abroad.

Figure A.23: **Effect of Posting Policy on Non-Tradable Market Shares: Drivers Case-Study**

A. Exports of Drivers' Road Transport Services by Exporting Country

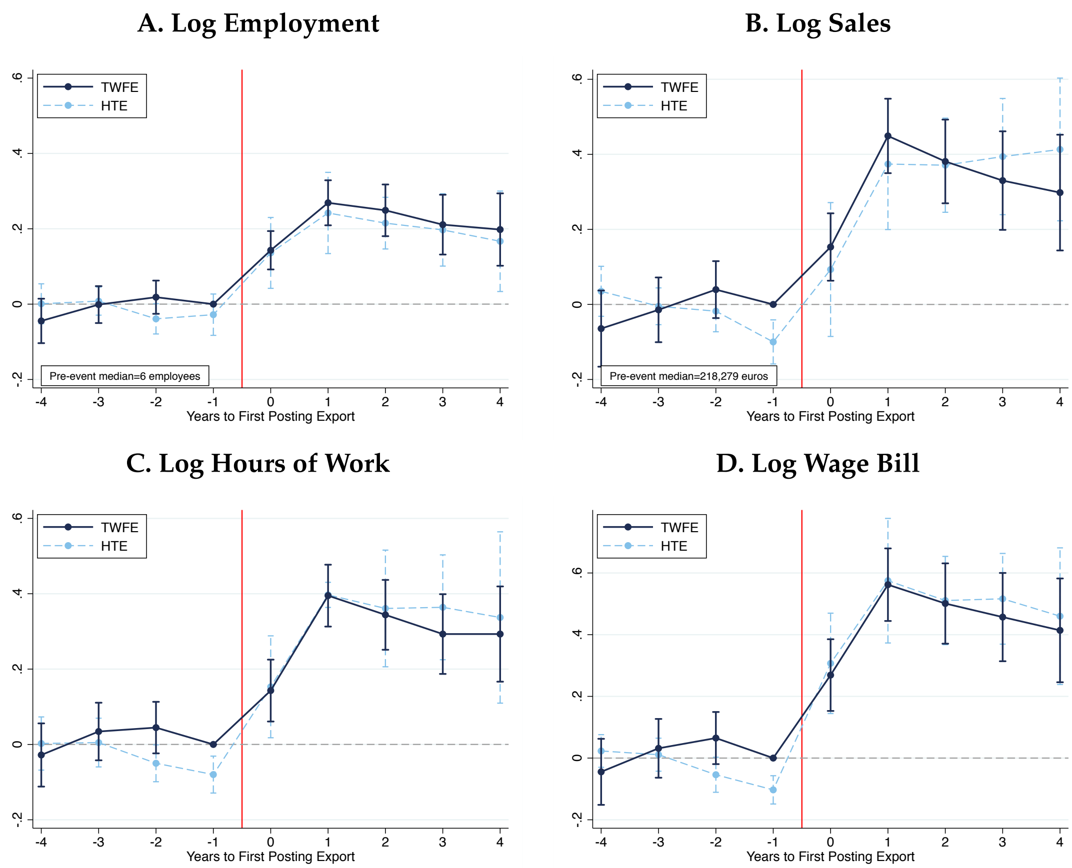


B. Total Drivers' Road Transport Services by Country



Notes: This figure shows the evolution of economic activity in the road transport service before and after that the posting policy was opened to NMS in 2004 (Poland, Slovakia, Slovenia, Estonia, Hungary). Economic performance in the road transport is measured in million-tonne kilometer performed by each country.

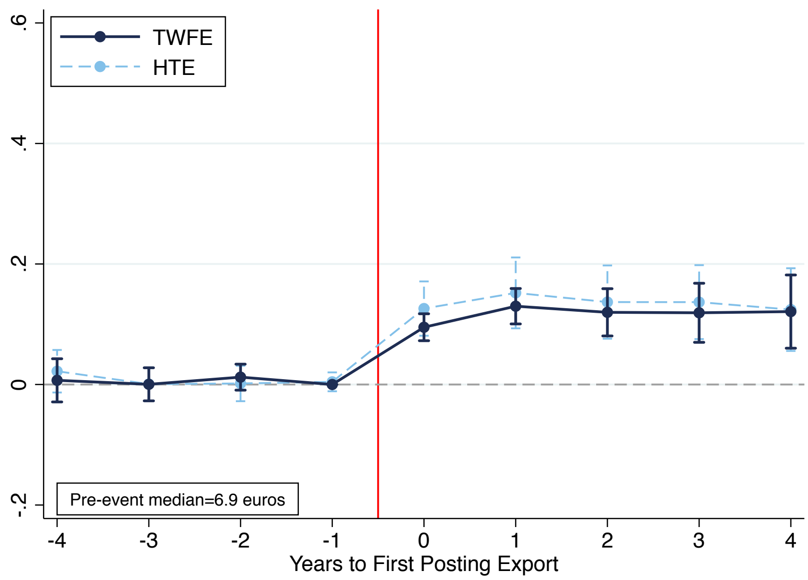
Figure A.24: **Sending Firms Expand When Starting to Provide Services Abroad**



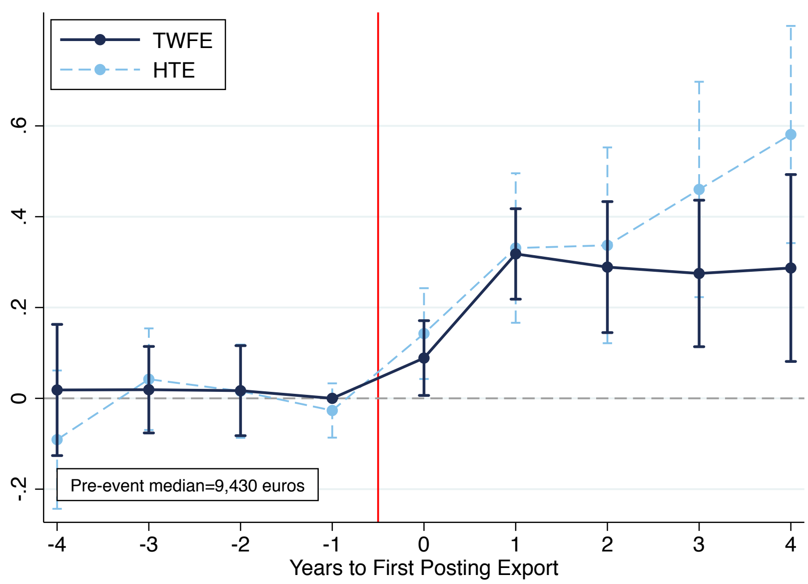
Notes: This figure studies how posting affects sending firms located in Portugal, one of the main suppliers of posting services in Europe. I use exhaustive administrative tax records of Portuguese firms merged with administrative records of services performed in another EU country from 2006 to 2017 to select the 4,151 firms (with a median of more than three employees over the period) that start posting workers abroad for the first time between 2010 and 2015. The figure plots the estimated event study coefficients θ_k from Equation (1.13) for the period 2006-2017 where the dependent variable is log number of paid employees (Panel A), log total hours worked by employees (Panel B), log total sales (Panel C), log domestic sales (Panel D), log total assets (Panel E), and log wage bill (Panel F). The event is defined as the first time a Portuguese firm provides non-tradable services in another EU country. The coefficient of the year before the first posting θ_{-1} is normalized to zero. The regressions include firm and five-digit sector $\times$ calendar year $\times$ province fixed effects. θ_k compares the outcomes of posting firms in event year k to the outcomes of future posting firms in the same narrowly defined sector and province in the year before their event. The vertical line represents 95% confidence intervals computed from robust standard errors clustered at the calendar year $\times$ province level. The event study coefficients are reported in Table 1.6. The dataset and estimation sample are described in Appendix.

Figure A.25: **Surplus-Sharing Between Sending Firms and Posted Workers**

A. Wage Rate After Provision of Services Abroad



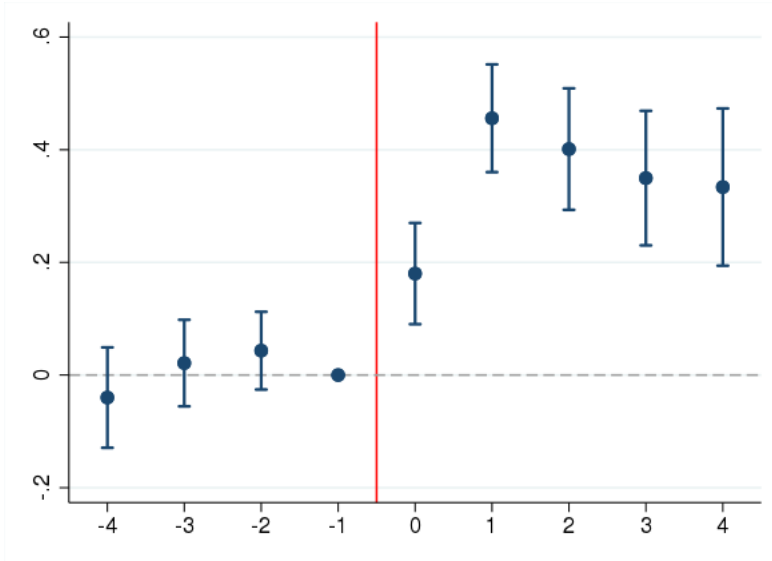
B. Profits After Provision of Services Abroad



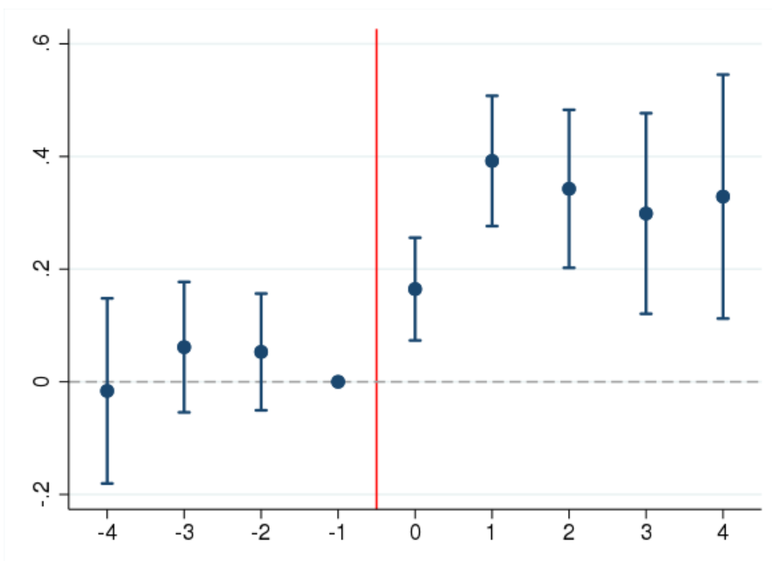
Notes: This figure studies how posting affects sending firms located in Portugal, one of the main suppliers of posting services in Europe. I use exhaustive administrative tax records of Portuguese firms merged with administrative records of services performed in another EU country from 2006 to 2017 to select the 4,151 firms (with a median of more than three employees over the period) that start posting workers abroad for the first time between 2010 and 2015. The figure plots the estimated event study coefficients θ_k from Equation (1.13) for the period 2006-2017 where the dependent variable is log wage rate (Panel A) and log earnings before taxes (Panel B). The event is defined as the first time a Portuguese firm provides non-tradable services in another EU country. The coefficient of the year before the first posting θ_{-1} is normalized to zero. The regressions include firm and five-digit sector $\times$ calendar year $\times$ province fixed effects. θ_k compares the outcomes of posting firms in event year k to the outcomes of future posting firms in the same narrowly defined sector and province in the year before their event. The vertical line represents 95% confidence intervals computed from robust standard errors clustered at the calendar year $\times$ province level. The event study coefficients plotted in the figure are reported in Columns (1)-(2) of Table 1.7. The dataset and estimation sample are described in Appendix. Estimates accounting for heterogeneous treatment effects are presented in Figure A.35 and in Figure A.25 together with pre-treatment median outcomes.

Figure A.26: **Fiscal Externality of Posting for Sending Governments**

A. Payroll Taxes at Sending Firms After Provision of Services Abroad

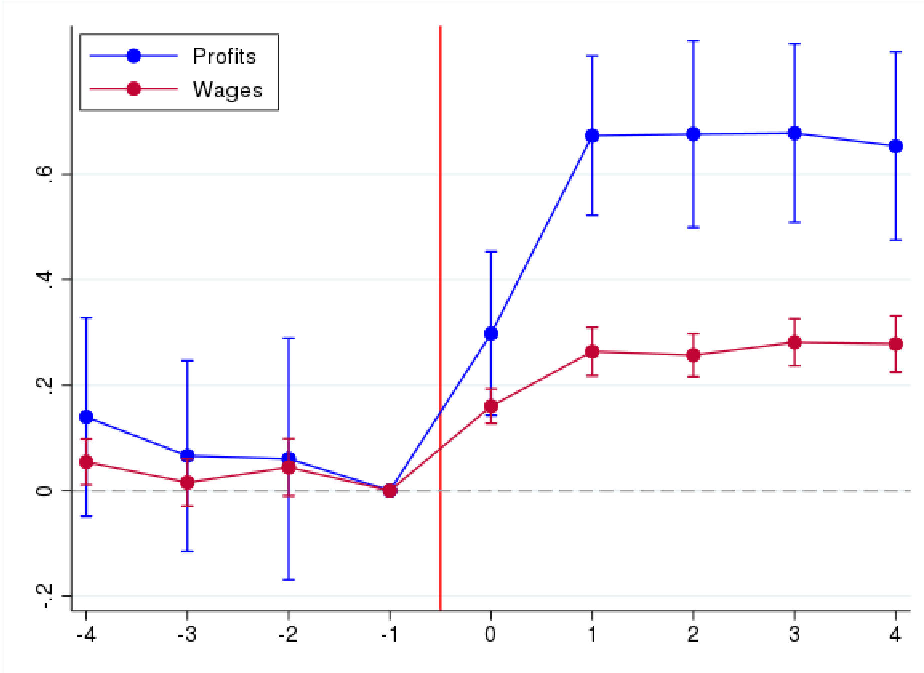


B. Corporate Income Tax at Sending Firms After Provision of Services Abroad



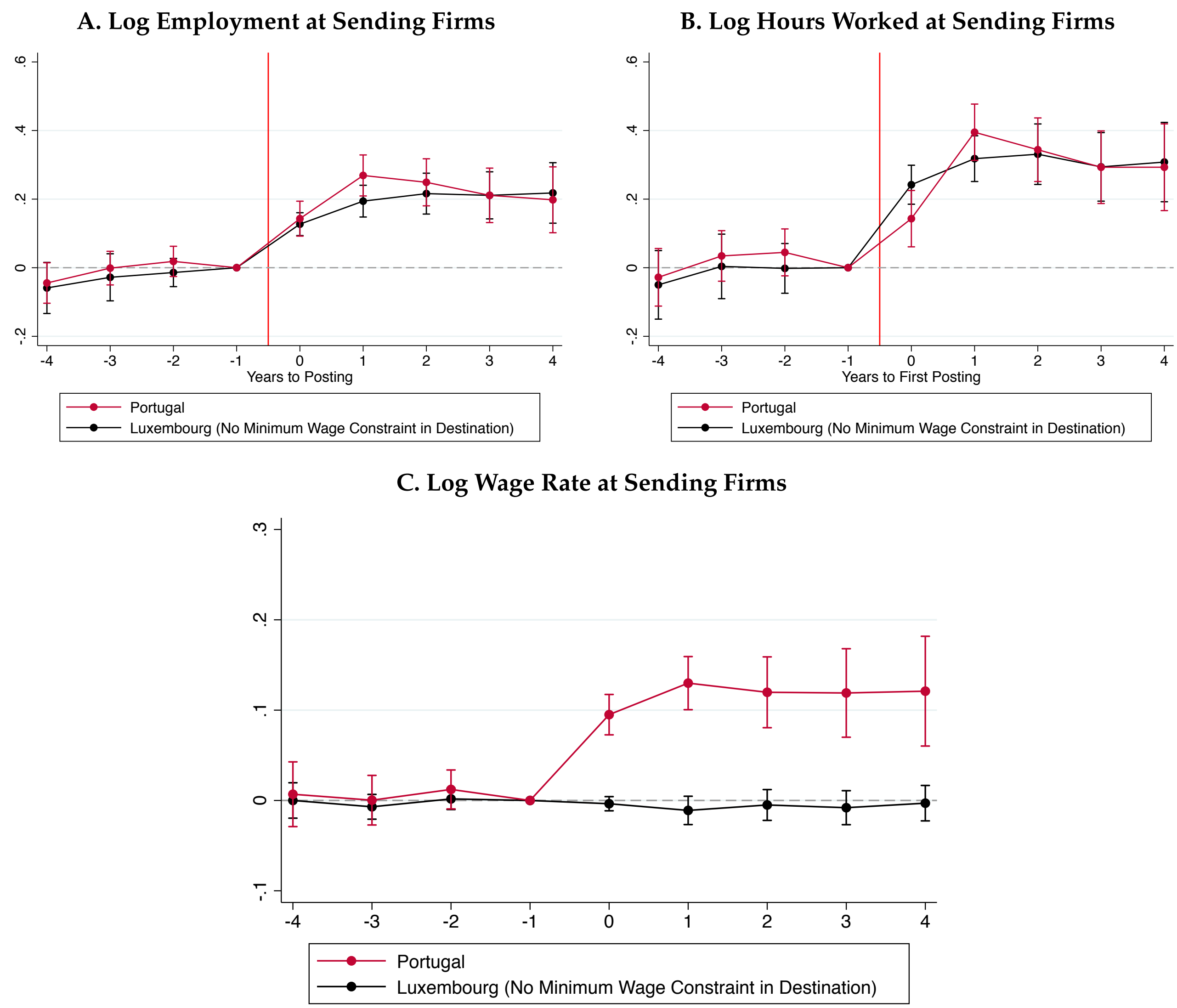
Notes: This figure studies how posting affects sending firms located in Portugal, one of the main suppliers of posting services in Europe. I use exhaustive administrative tax records of Portuguese firms merged with administrative records of services performed in another EU country from 2006 to 2017 to select the 4,151 firms (with a median of more than three employees over the period) that start posting workers abroad for the first time between 2010 and 2015. The figure plots the estimated event study coefficients θ_k from Equation (1.13) for the period 2006-2017 where the dependent variable is log social security contributions (Panel A) and log paid corporate income tax (Panel B). The event is defined as the first time a Portuguese firm provides non-tradable services in another EU country. The coefficient of the year prior to the first posting θ_{-1} is normalized to zero. The regressions include firm and five-digit sector $\times$ calendar year $\times$ province fixed effects. The vertical line represents 95% confidence intervals computed from robust standard errors clustered at the calendar year $\times$ province level. The dataset and estimation sample are described inAppendix.

Figure A.27: **Profits-Wage Split At Permanent Sending Firms**



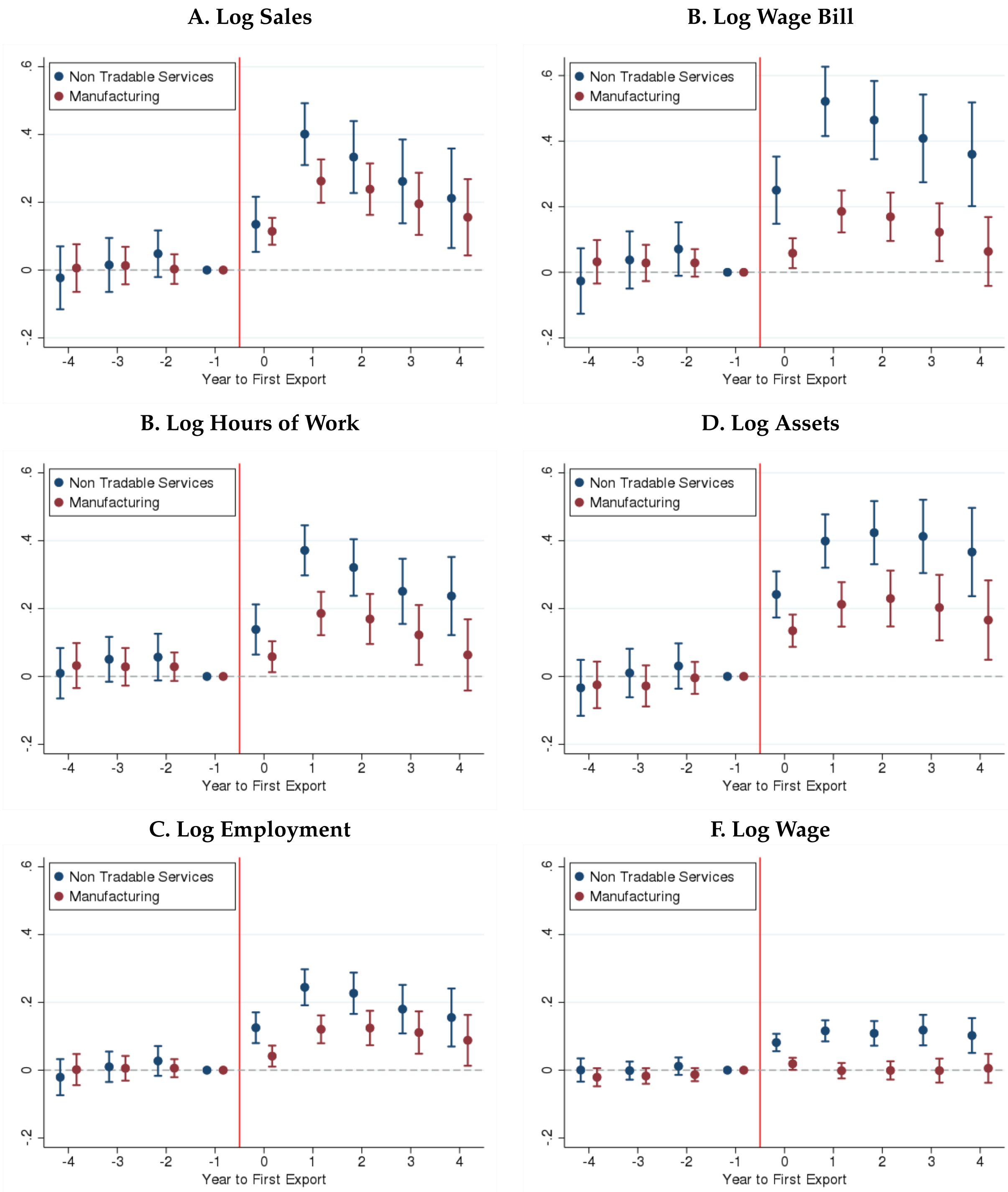
Notes: This figure studies how posting affects sending firms located in Portugal, one of the main suppliers of posting services in Europe. I use exhaustive administrative tax records of Portuguese firms merged with administrative records of services performed in another EU country from 2006 to 2017 to select the 4,151 firms (with a median of more than three employees over the period) that start posting workers abroad for the first time between 2010 and 2015. This figure restricts the analysis to sending firms that permanently provide services abroad after their first posting event. The figure plots the estimated event study coefficients θ_k from Equation (1.13) for the period 2006-2017 where the dependent variable is log wage rate (pink series) and log earnings before taxes (blue series). The event is defined as the first time a Portuguese firm provides non-tradable services in another EU country. The coefficient of the year before the first posting θ_{-1} is normalized to zero. The regressions include firm and five-digit sector $\times$ calendar year $\times$ province fixed effects. θ_k compares the outcomes of posting firms in event year k to the outcomes of future posting firms in the same narrowly defined sector and province in the year before their event. The vertical line represents 95% confidence intervals computed from robust standard errors clustered at the calendar year $\times$ province level. The dataset and estimation sample are described in Appendix.

Figure A.28: **Posted Workers' Wage Gains Come From Regulation Rather Than Surplus-Sharing**



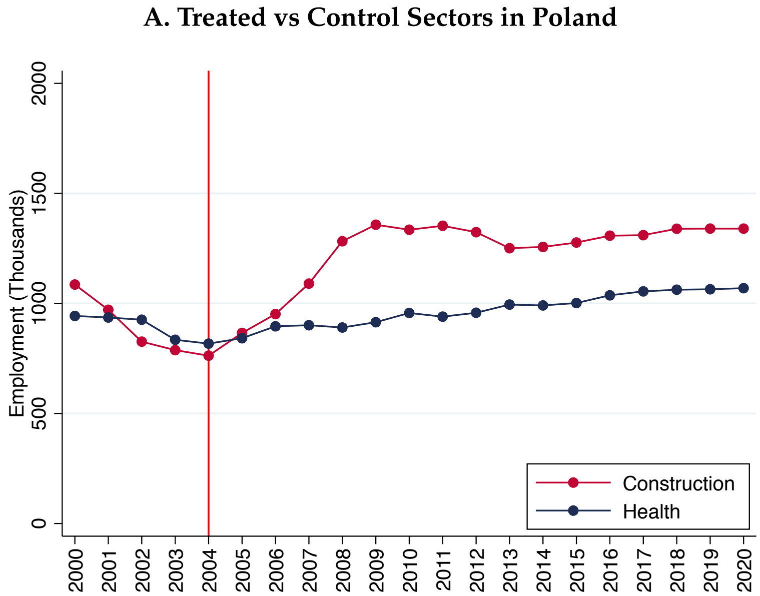
Notes: This figure compares sending firms' outcomes after a first posting event for firms located in two different countries affected differentially by destination-country minimum wages: Portugal and Luxembourg. I use exhaustive administrative tax records of Portuguese firms merged with administrative records of services performed in another EU country from 2006 to 2017. I use exhaustive administrative employment registries of Luxembourgish firms merged with administrative records of services performed in another EU country from 2002 to 2020. To ensure comparability of these two samples, I focus on Luxembourgish firms operating in the same sectors than posting firms in Portugal, which are listed in Appendix and represent 70% of postings from Luxembourg. My two samples are: (i) the 4,151 Portuguese firms that start posting workers abroad for the first time between 2010 and 2015 and (ii) the 1,286 Luxembourgish firms that start posting workers for the first time between 2007 and 2017. The figure juxtaposes the estimated event study coefficients θ_k from Equation (1.13) estimated separately on posting firms in Portugal (red) and posting firms in Luxembourg (black). The event is defined as the first time a firm posts workers to another European member states, and the dependent variable is the log number employees (Panel A), log hours of work (Panel B), and log average wage at sending firm (Panel C). The coefficient of the year before the first posting θ_{-1} is normalized to zero. All regressions include firm fixed effects, five-digit sector $\times$ calendar year $\times$ province fixed effects for Portugal, and five-digit sector $\times$ calendar year for Luxembourg (no provinces). The vertical line represents 95% confidence intervals computed from robust standard errors clustered at the event time $\times$ province level for Portugal and at the event time $\times$ five-digit sector for Luxembourg.

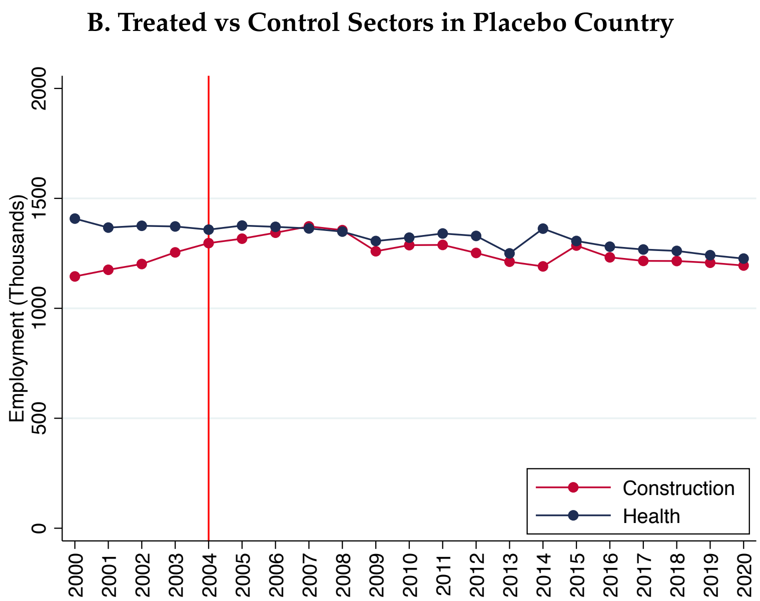
Figure A.29: **Firms' Scale Up After First Export: Manufacturing Goods vs Posting Services**



Notes: This Figure studies how export events affect firms located in Portugal, one of the main supplier of posting services in Europe. I use exhaustive administrative tax records of Portuguese firms merged with administrative records of services performed in another EU country, as well as goods exported abroad, from 2006 to 2017 to identify two samples. The first sample is the group of 4,151 firms that start posting workers abroad for the first time between 2010 and 2015. The second sample if the group of manufacturing firms that start exporting manufactured goods abroad for the first time between 2010 and 2015. The Figure juxtaposes the estimated event study coefficients θ_k from Equation (1.13) estimated separately on (i) manufacturing exporters (red) and (ii) posting firms (blue). The event is defined as the first time a Portuguese firm post (blue) or export (red) abroad. The regressions include 5-digit sector $\times$ calendar year $\times$ province fixed effects. The vertical line represent 95% confidence intervals computed from robust standard errors clustered at the event-time $\times$ province level. Sample and descriptive statistics can be found in Appendix.

Figure A.30: **Effects of the Liberalization Reform on Sending Country Employment**

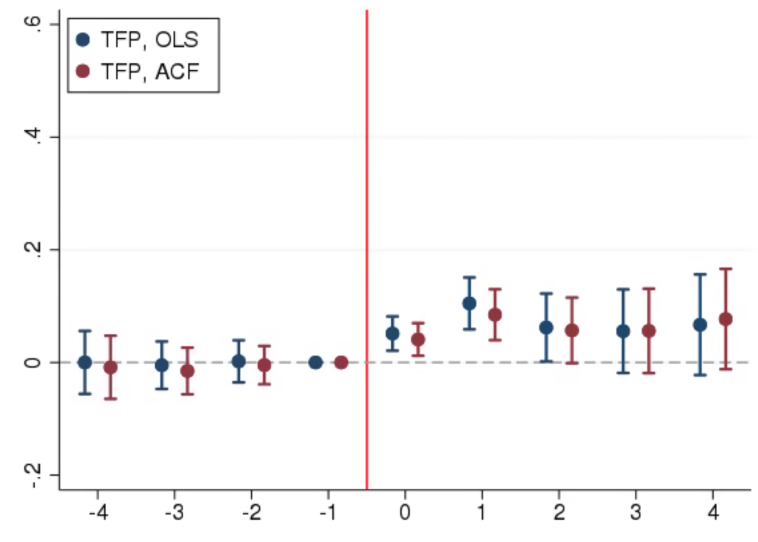




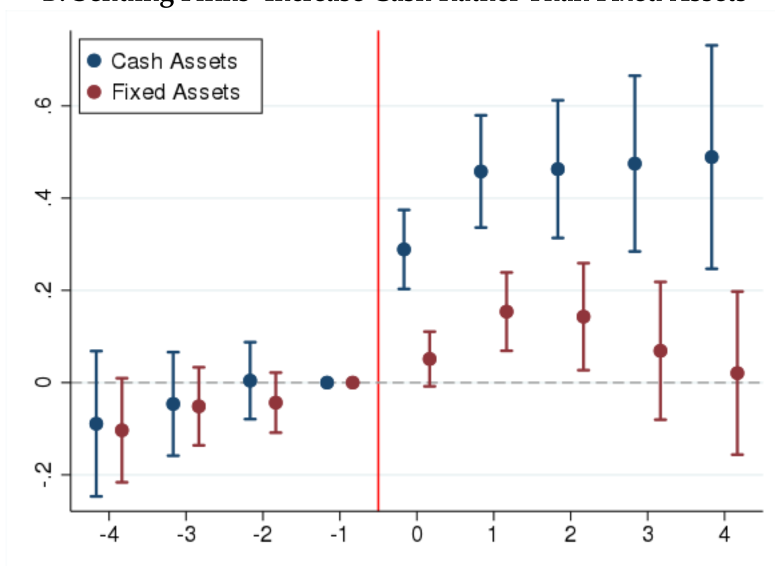
Notes: This figure shows the aggregate employment effects of posting openness for Poland, the first supplier of posting services since 2005. The analysis is a triple differences approach that compares employment in exposed versus unexposed sectors before and after an exogenous posting openness shock in countries affected and not affected by the shock. Poland became a EU member state in 2004. That year, all mobility restrictions for employees posted by Polish suppliers were lifted, except for postings from Poland to Austria and Germany that were deregulated in 2011 (the first-stage effects of these mobility reforms are analyzed in Figure 1.4). Most of the postings from Poland occur in the construction sector, while regulated sectors like health, education, or public administration are covered by licensing regulations that prevent them from being performed abroad. Construction services can only be exported through posted workers: construction sectors should be directly affected by the liberalization but not by other trade tariff liberalizations that could occur simultaneously with the EU accession event. Panel A shows the differential evolution of Polish employment in exposed (red series) versus non-exposed sectors (blue series) before and after the posting openness shock of 2004 (red vertical line). Panel B repeats the analysis for a neighboring country, Ukraine, that never gained access to EU membership and therefore to free posting in the EU.

Figure A.31: **Capital and TFP At Sending Firms**

A. TFP At Sending Firms



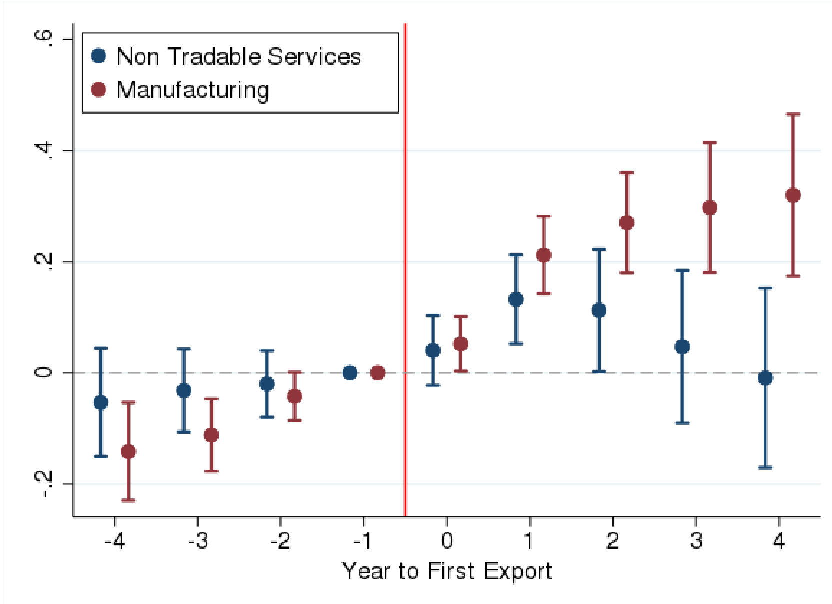
B. Sending Firms' Increase Cash Rather Than Fixed Assets



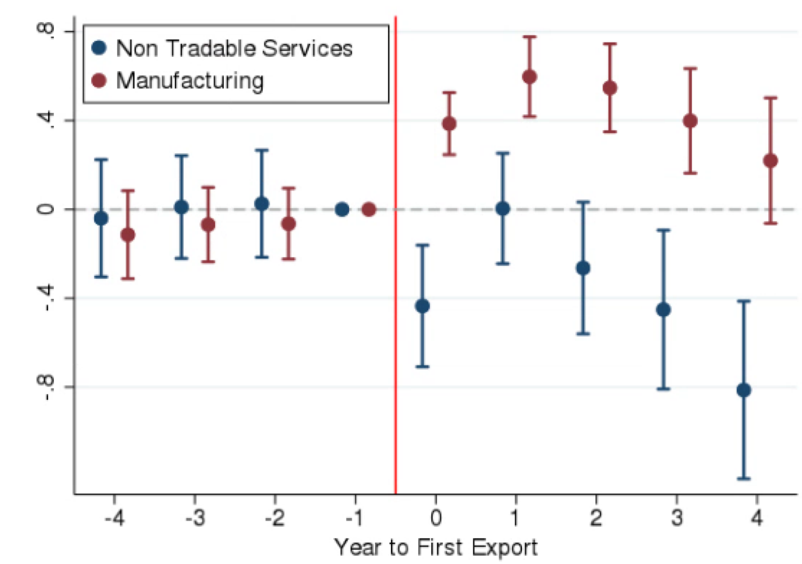
Notes: This Figure studies how posting affects sending firms located in Portugal, one of the main supplier of posting services in Europe. I use exhaustive administrative tax records of Portuguese firms merged with administrative records of services performed in another EU country from 2006 to 2017 to select the 4,151 firms -with a median of more than 3 employees over the period- that start posting workers abroad for the first time between 2010 and 2015. In Panel A, I measure TFP assuming a standard Cobb-Douglas technology, using a simple OLS framework where sales are the dependent variable and where employment, net assets and cost of materials are used as time varying controls. To take into account potential endogeneity in input choices at the service supplier level, the red serie relies on the method proposed by **?** (henceforth ACF) to compute an alternative measure of TFP. The event is defined as the first time a Portuguese firm provide non-tradable services in another EU country. The coefficient of the year prior to the first posting θ_{-1} is normalized to zero. The regressions include 5-digit sector $\times$ calendar year $\times$ province fixed effects. θ_k compares the outcomes of posting firms in event year k to the outcomes of future posting firms in the same narrowly defined sector and province in the year before their event. The vertical line represent 95% confidence intervals computed from robust standard errors clustered at the calendar year $\times$ province level. The dataset and estimation sample is described in Appendix. Figure B compares θ_k using tangible assets (red) and cash assets (blue) as dependent variables.

Figure A.32: **Industry-Specificities In Export Behavior: Non-Tradables vs Manufacturing**

A. Manufacturing Firms Select Into Exporting By Buying Tangible Assets

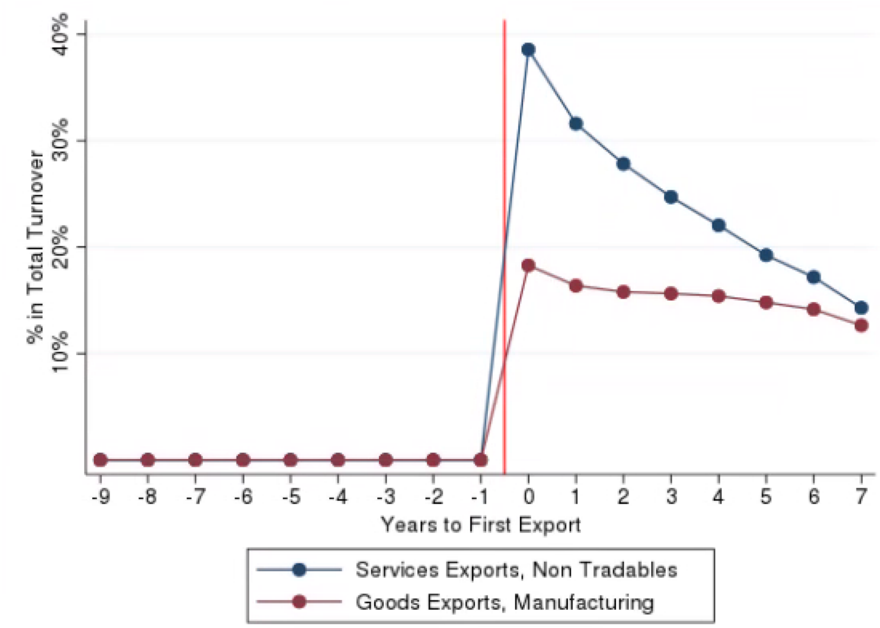


B. Services Suppliers Shift From Domestic to Foreign Sales After First Export



Notes: This Figure studies how export events affect firms located in Portugal, one of the main supplier of posting services in Europe. I use exhaustive administrative tax records of Portuguese firms merged with administrative records of services performed in another EU country, as well as goods exported abroad, from 2006 to 2017 to identify two samples. The first sample is the group of 4,151 firms that start posting workers abroad for the first time between 2010 and 2015. The second sample if the groupe of manufacturing firms that start exporting manufactured goods abroad for the first time between 2010 and 2015. The Figure juxtaposes the estimated event-study coefficients θ_k from Equation (1.13) estimated separately on (i) manufacturing exporters (red) and (ii) posting firms (blue). The event is defined as the first time a Portuguese firm post (blue) or export (red) abroad. The dependent variable is log tangible assets (Panel A) and log domestic sales (Panel B). The regressions include 5-digit sector $\times$ calendar year $\times$ province fixed effects. The vertical line represent 95% confidence intervals computed from robust standard errors clustered at the event-time $\times$ province level. Sample and descriptive statistics can be found in Appendix.

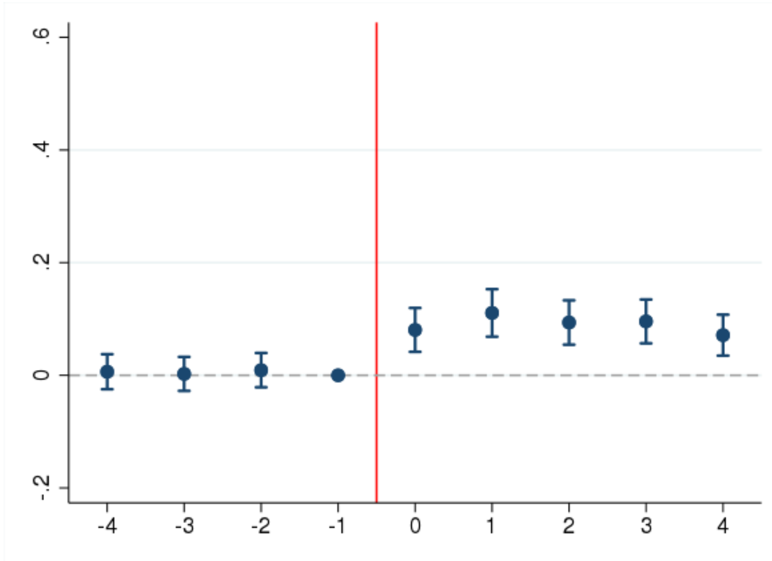
Figure A.33: **Intensity and Persistence of Exports**



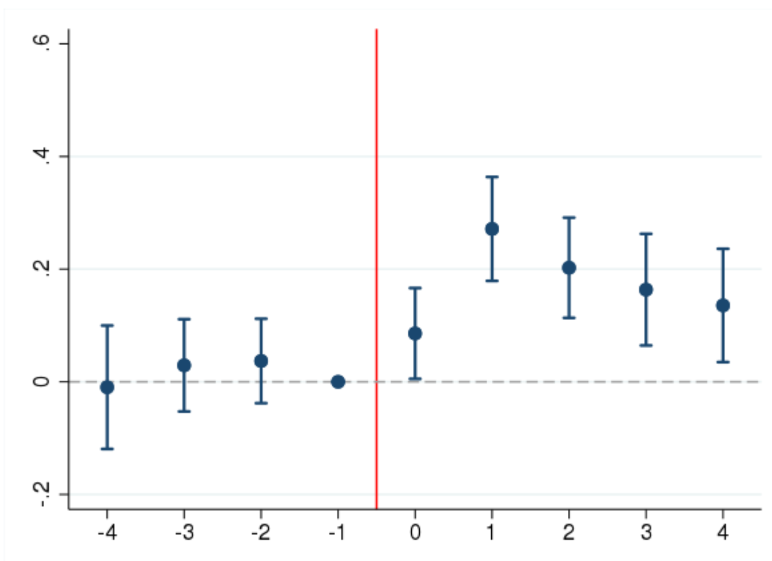
Note: This Figure shows the intensity of "first export" treatment for firms in manufacturing on non-tradable services industries. The dataset used is a detailed administrative firm-level balance-sheets data covering the universe of non-financial companies operating in Portugal between 2006 and 2017 merged with exhaustive information on trade in goods and services at the company-level. First export is defined for all firms that are observed exporting for the first time between 2010 and 2015, such that we can observe at least 4 years without export for firms that start exporting in 2007. The Figure displays the average exports/turnover ratio in years before and after first exports for exporters in manfuacturing (red) and non tardable services (blue).

Figure A.34: **Export-Mobility Surplus: Using Non-Postable Sectors As Additional Control Groups**

A. Wage Rate Evolution Around First Provision of Services Abroad

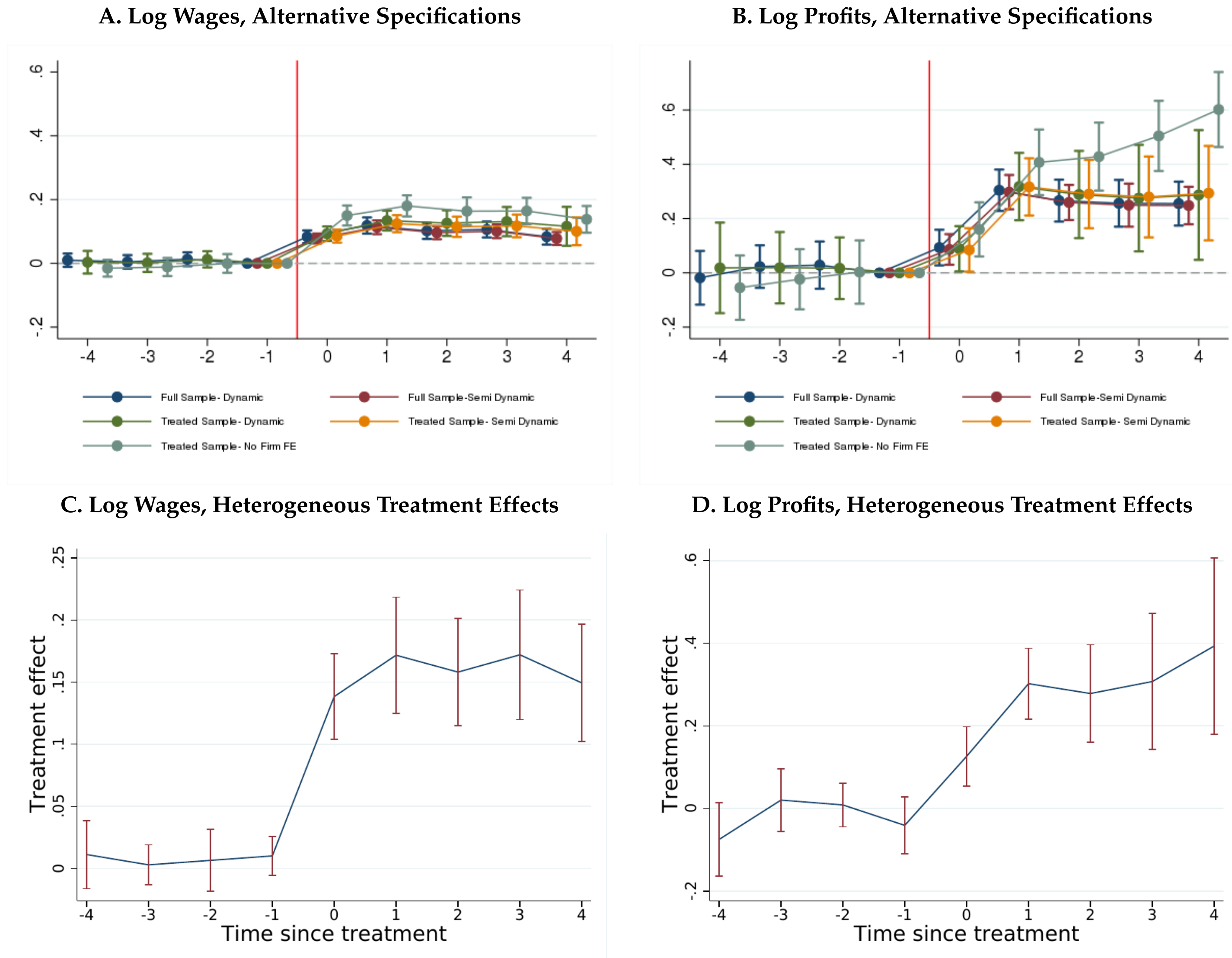


A. Profits Evolution Around First Provision of Services Abroad



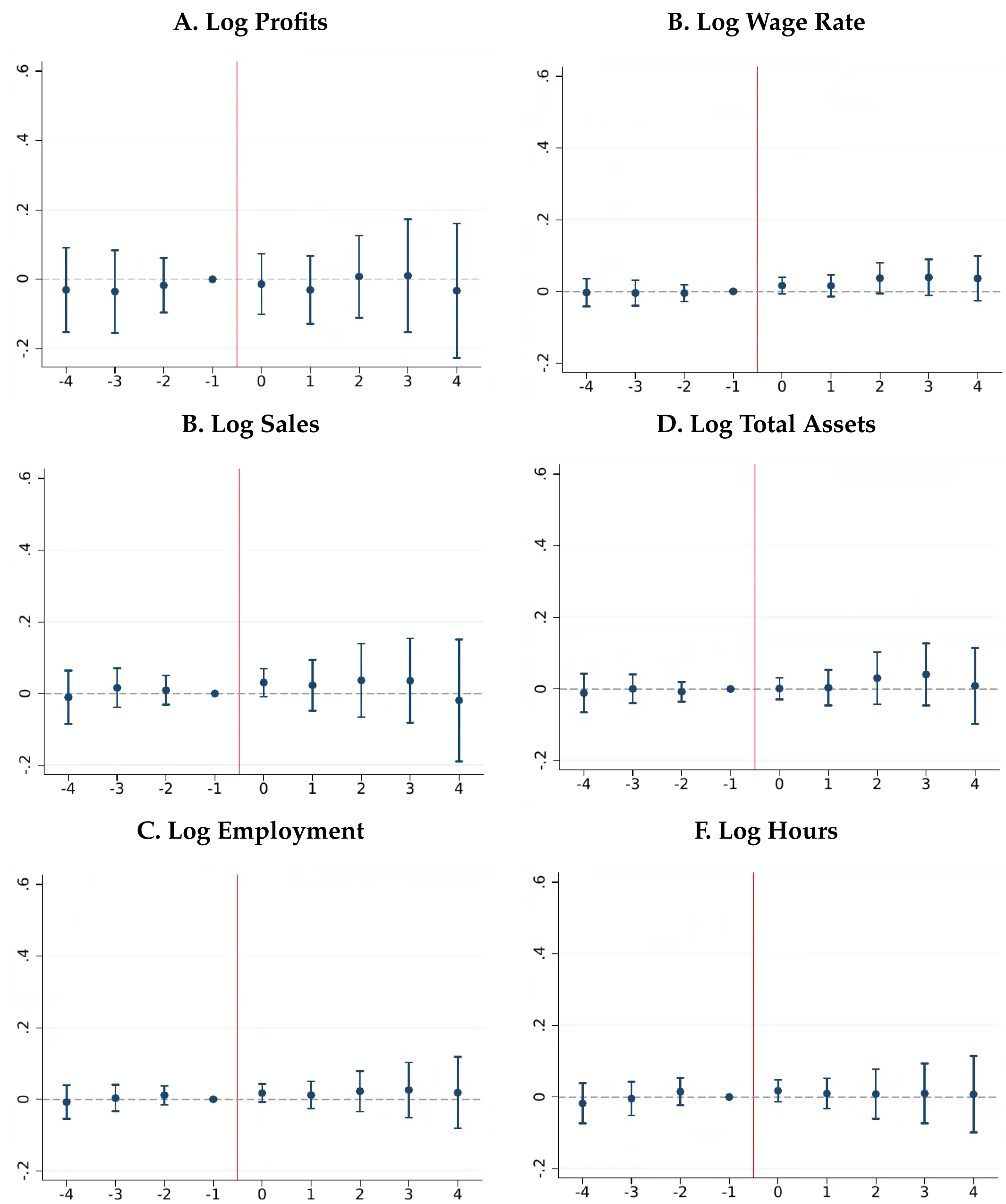
Notes: The Figure repeats the baseline analysis by adding firms in services sheltered from posting opportunities as additional control groups. This include firms operating in services activities that are not easily performed by mobile employees sent abroad, such as hotels, beauty salons, retail stores, licensed health professions etc. Provision of services abroad represent less than 2% of these sheltered sectors turnover. The Figure plots the estimated event-study coefficients θ_k from Equation (1.13) for the period 2006-2017 using the baseline 4,151 treated firms and the group of firms in non-postable industries as control group. The regressions include calendar year $\times$ province fixed effects and standard errors are clustered at the calendar year $\times$ province level. The dataset and estimation sample is described in Appendix.

Figure A.35: **Robustness to Baseline DiD**



Notes: The Figure plots the estimated event-study coefficients θ_k from Equation (1.13) where the dependent variable is log wage rate (Panel A) and log earnings before taxes (Panel B) for various specifications. See the footnote under Figure 1.14 for details about the specification. The blue line shows the estimates of Equation (1.13) for all firms (4,151 treated firms and 28,803 control firms that never provide services abroad over the period), while the green line uses the restricted sample with only treated firms (baseline specification). The red and yellow line shows the estimates of the baseline event-study specification in a semi-dynamic fashion with θ_k specified for only $k > 0$, while light green line omits firms' fixed effects in the baseline specification. These tests help to assess the plausibility of heterogeneous treatment effects and negative weightinhg issues in the baseline twoway fixed-effects specification, and follow suggestions by **?**. The Figure uses an alternative estimator developped by **?** that corrects for negative weighting and is robust to negative weighting, using the build-in commant multiple_did gt in stata.

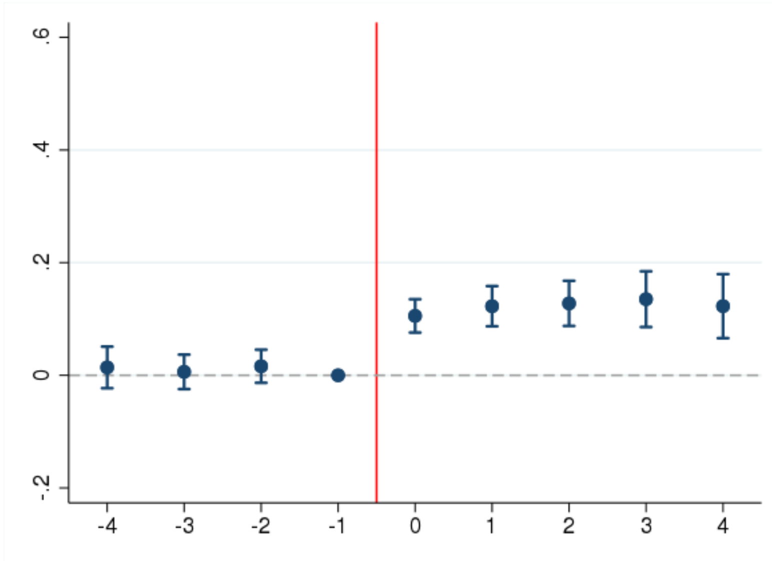
Figure A.36: **Posting Surplus: Effects of Placebo Posting Events on Sending Firms**



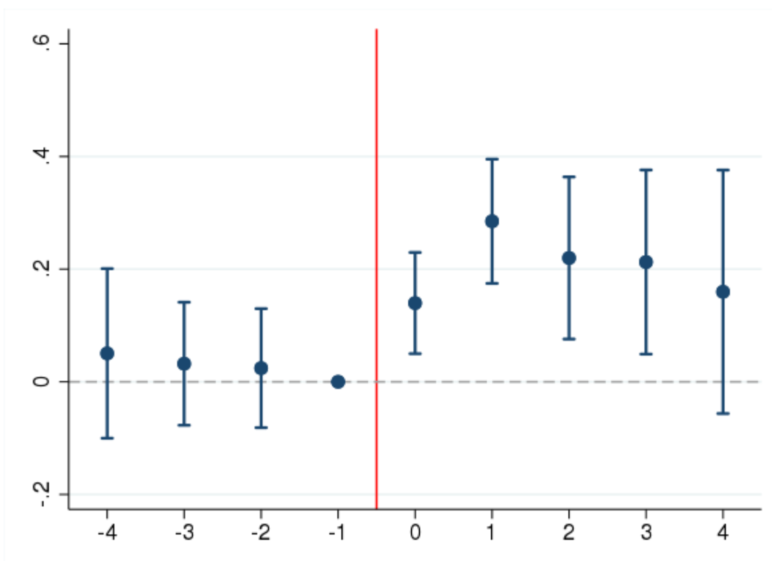
Notes: The figure repeats the baseline analysis presented in Figure 1.14 and Figure 1.12 by replacing the "first provision of services abroad event" by a placebo event. The placebo event year is randomly attributed across treated firms. All controls are the same than in the baseline analysis and are described in footnote of Figure 1.14 and Figure 1.12.

Figure A.37: **Posting Surplus: Robustness to Balancing the Sample**

A. Wage Rates Around First Posting



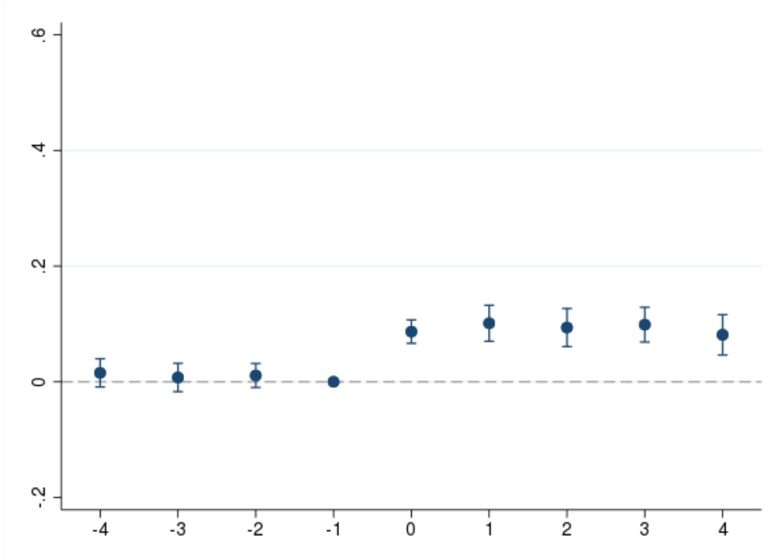
B. Profits Around First Posting



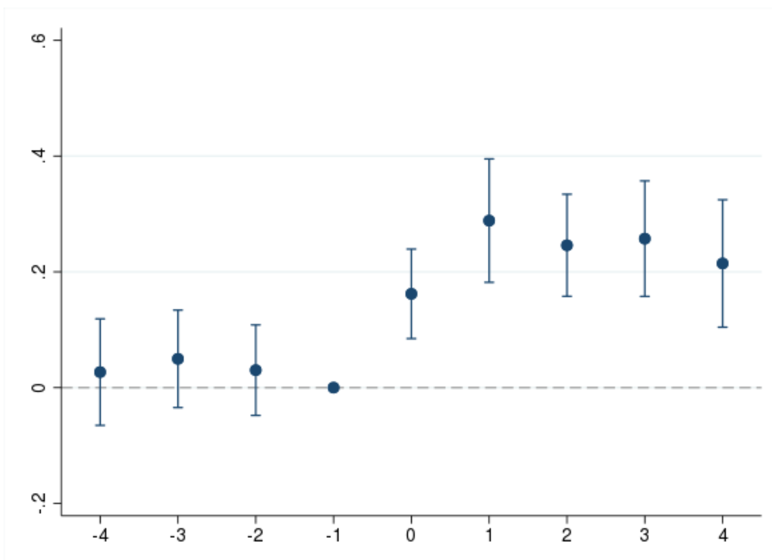
Notes: The Figure repeats the estimates plotted in Figure 1.14 where the baseline sample of estimation is balanced around event-time, keeping only firms that are observed the year prior and the year after the event of firms posting.

Figure A.38: **Posting Surplus: Alternative Matching Estimators**

A. Wage Rates Around First Posting



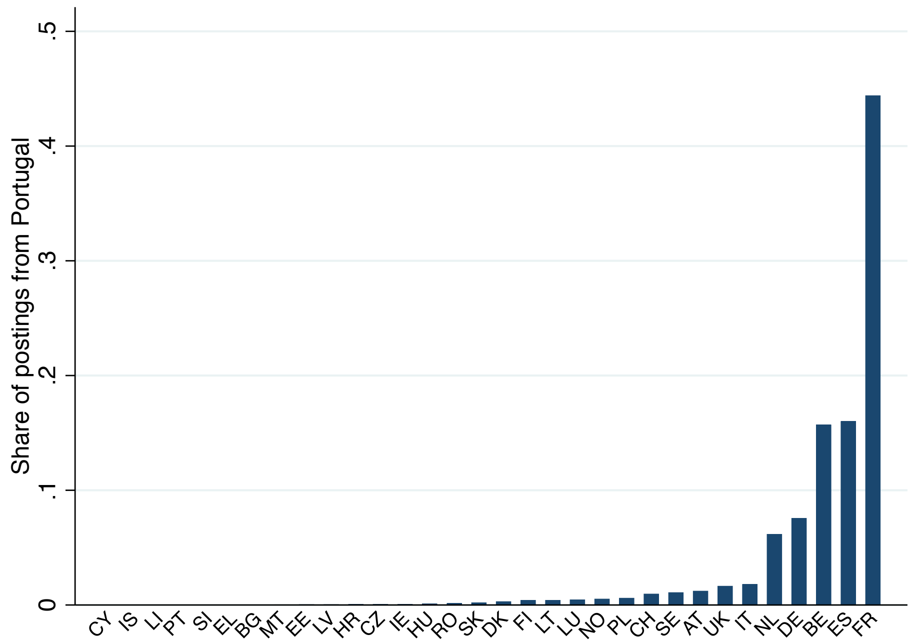
B. Profits Around First Posting



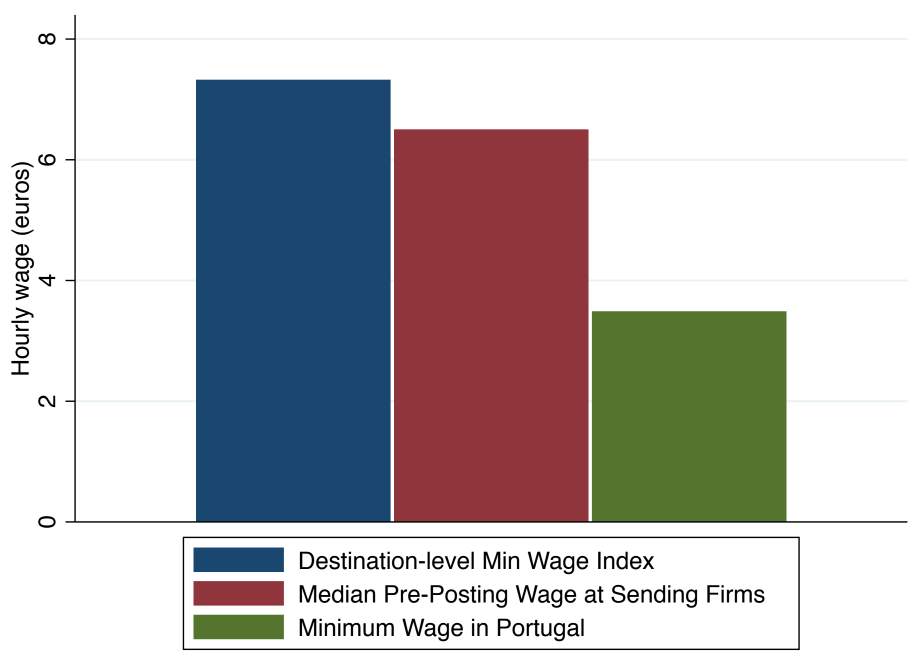
Notes: The Figure repeats the estimates plotted in Figure 1.14 using an alternative control groups built with matching method. More specifically, I match each treated firm observed as providing services abroad for the first time between 2020 and 2015 with a comparable firm that did not provide services abroad over the same period. The matching uses a propensity score matching to match treated firms with control firms in same province and sector, as well as with close pre-treatment characteristics (sales and number of employees). I then re-estimate Equation (1.13) with this novel control group.

Figure A.39: **Destination-Level Minimum Wage Requirements for Portuguese Firms**

A. Posting Services Exported by Portugal by Receiving Country

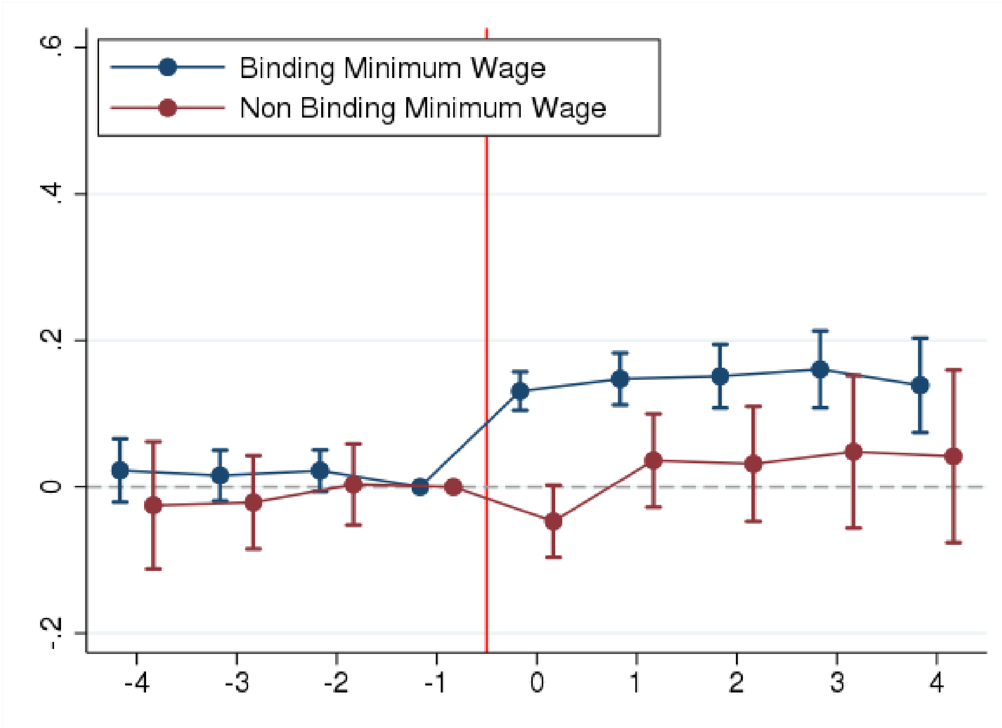


B. Destination-Level Minimum Wage Requirements Faced by Portuguese Firms



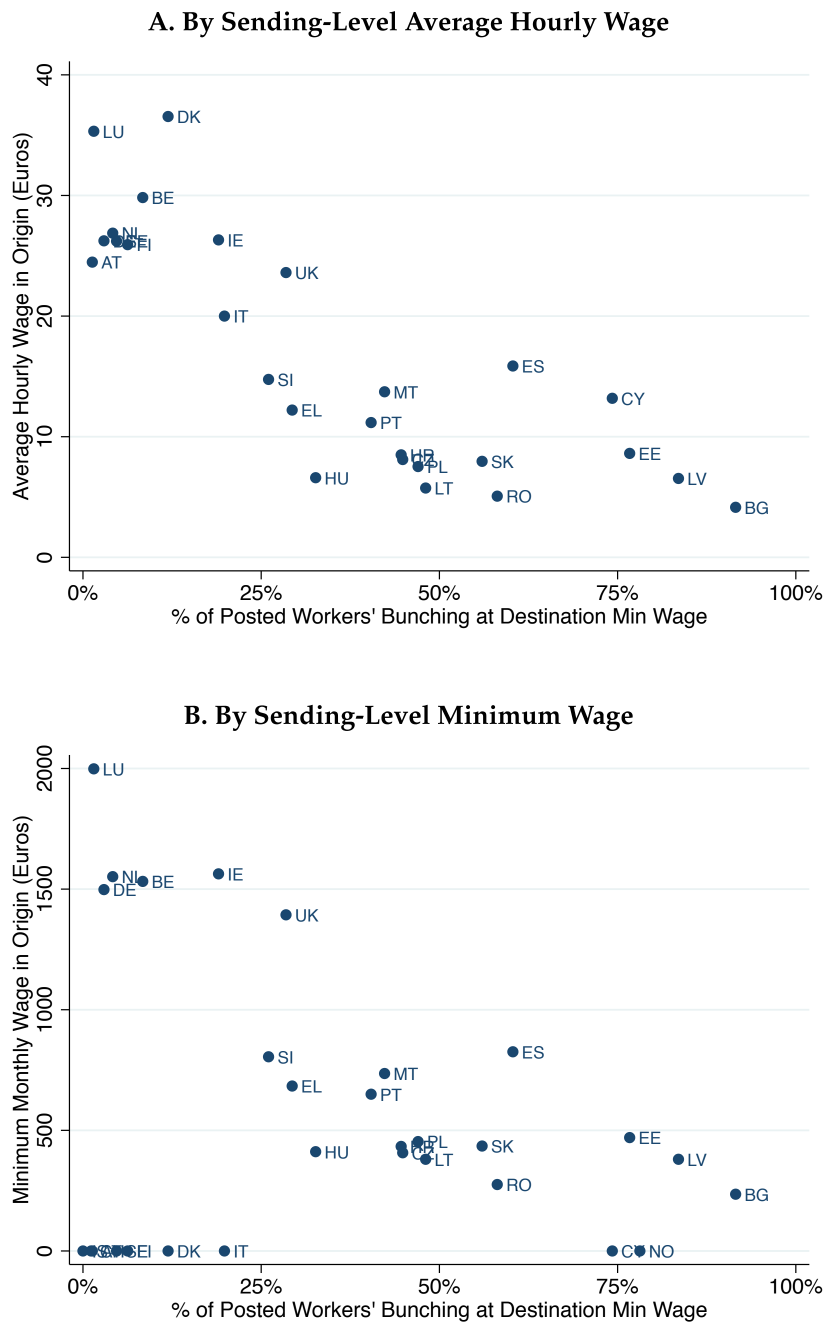
Notes: This figure describes destination-level minimum wage constraints faced by sending firms located in Portugal. The top panel shows the aggregate distribution of receiving countries for all missions performed by Portuguese companies, and is based on the EU-wide dataset on bilateral posting flows from A1 social security forms. The bottom panel shows the average destination minimum wage index faced by Portuguese companies based on the aggregate decomposition of receiving countries (blue bar). The red bar shows the median level of wages paid by sending firms the year before they start posting workers abroad.

Figure A.40: **Posted Workers' Wage Gains By Pre-Posting Bindingness of Wages**



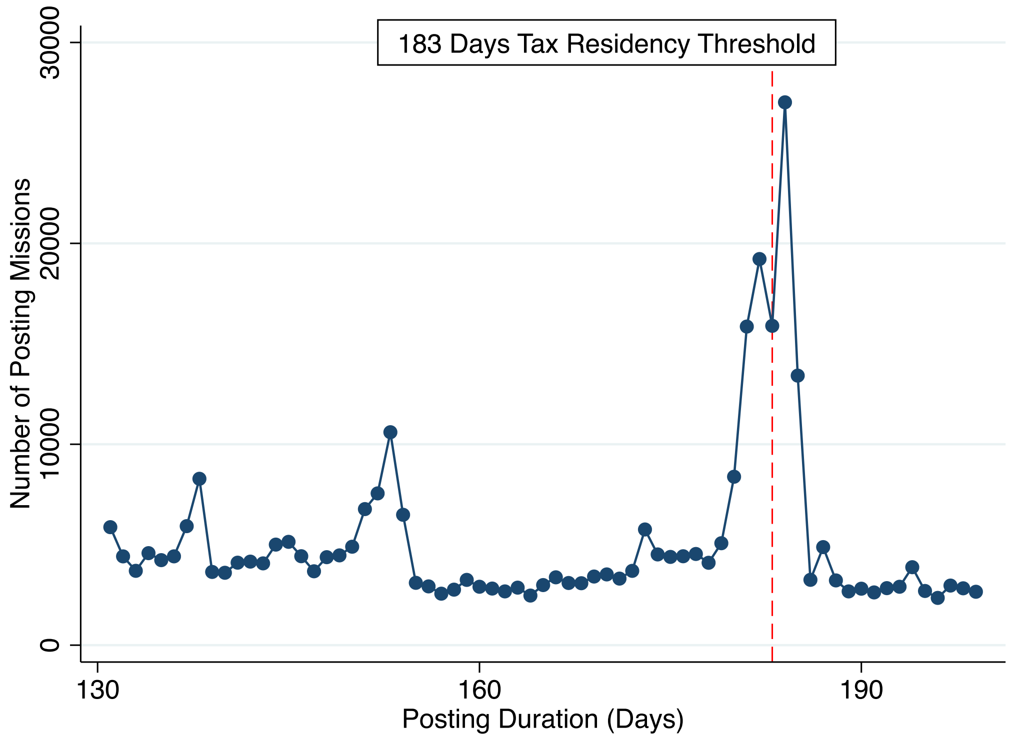
Notes: The Figure estimates Equation (1.13) using log wage as a dependent variable on two separate sample of sending firms located in Portugal. The blue line shows the estimated of θ_k for firms with a pre-posting level of wage below the average destination-level minimum legal wage index. As posted workers cannot be paid under the destination-level minimum legal wage, these firms should be constrained to increase their workers' wages when supplying services abroad. The red series shows the same estimates for sending firms with pre-posting wages above the average destination-level minimum legal wage.

Figure A.41: **Bunching at Destination-Level Minimum Wage by Sending-Level Wage**



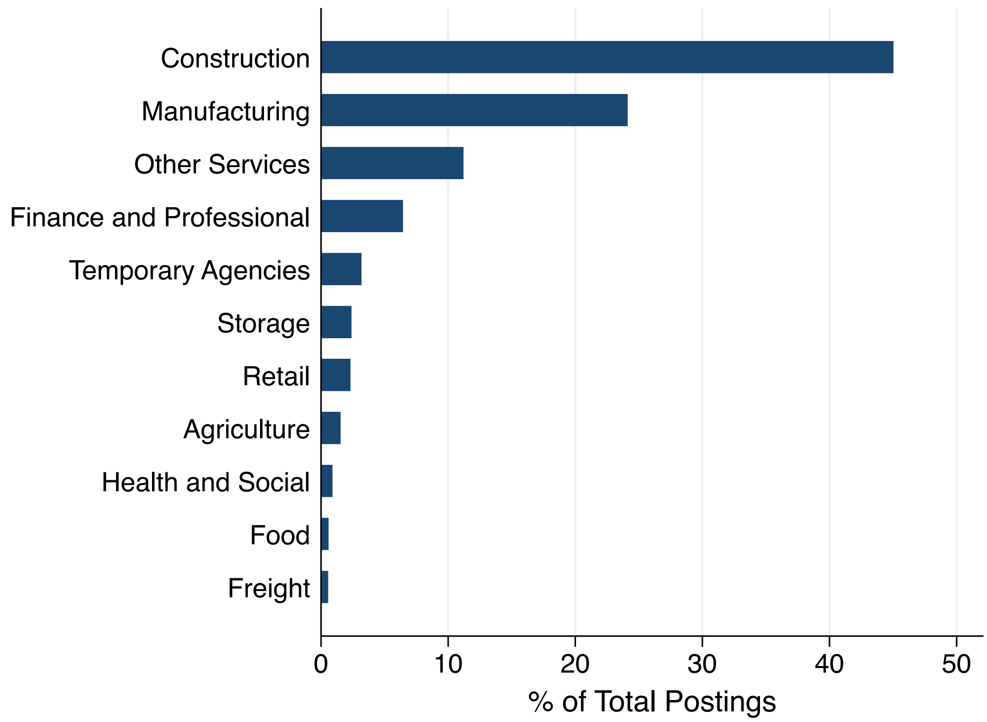
Notes: Posted workers cannot be paid under destination-level minimum legal wage. This Figure shows the relationship between destination-level wage and wages paid to posted workers in the second largest importer of posting services: France. I use the universe of mandatory posting declarations filed by foreign suppliers that send posted workers in the French territory (DPD/SIPSI dataset) from 2016 to 2020. The posting declarations contain information on wages paid by foreign firms to their employees posted in France during the posting mission, as well as detailed information on the posting contract. I use this information to compute the share of posted workers who are paid exactly at the minimum wage in France ("bunching at minimum wage") for each origin country. The share of posted workers bunching at destination-level minimum wage helps to assess the bindingness of the "prevailing wage" clause imposed by the posting policy. Panel A plots the relationship between origin country average hourly rate and the share of workers posted from that country that are paid exactly at the French minimum wage. Panel B plots the relationship between origin country minimum wage and the share of workers posted from that country that are paid exactly at the French minimum wage. Some origin countries have no minimum legal wage (Denmark, Italy etc).

Figure A.42: **Posting Duration Around the Income Tax Residency Threshold in Belgium**



Notes: The Figure shows the distribution of posting missions duration in Belgium for the period 2008-2019 around the 183 days tax residency threshold that is depicted by the vertical dashed line. International tax treaties establish that individuals pay income taxes in the country where the work activity is performed. However, if the employer is not located in the country where the work mission is performed by its employee, and if the employee works less than 183 days in the country of work, the income tax is exceptionnally levied by the country of residence, and not the country of work. On the other hand, if the employee works for more than 183 days in one country, the income tax on the wage received for the work mission is levied by the country of work, and not the country of residence. The income tax rate paid by posted workers for the wage earned abroad thus depends on the 183 days threshold. In addition of the rules related to part of the wage earned abroad, the 183 days rule can also affect total tax residency determination. If workers do not have a "central financial interest" in their country of origin, they become tax resident of the country of work if they stay more than 183 days in this country.

Figure A.43: **Posting of Workers by Sector of Work and Sending Member State**



Notes: The Figure shows the sectoral composition of posted workers flows by sending member states in 2015. Data on posted workers flows build on social security forms issued for postings and collected from the European Commission for the period 2006-2017.

Table A.1: **Administrative Datasets on the European Posting Policy**

Dataset	Source	Period	Description	Posting
EC/A1	EC	2007-2017	Universe of SSC Forms Issued for posting in the EU	Yearly bilateral posted workers flows in the EU (by sector for some member states)
DPD/SIPSI	DGT/DARES	2000-2019	Universe of Administrative Forms for Workers posted to France	Yearly flows at the sending country-receiving province-sectoral level until 2015, individual data linkable to receiving companies and workers for 2016-2019
LIMOSA	ONSS/CBSS	2010-2019	Universe of Administrative Forms for Workers posted to Belgium	Individual-level data linkable to receiving firms data
GOTOT-OUT	ONSS/CBSS	2007-2019	Universe of Administrative Forms for Workers posted from Belgium	Individual-level data linkable to sending firms data
CBHP	BoP	2006-2017	Universe of Portuguese Firms' Balance Sheets data merged with data on Service Prestation to the EU Market	Identify companies sending their workers abroad to perform services
IGSS	IGSS	2002-2017	Universe of Matched Employer-Employee Data in Luxembourg	Identify workers hired in Luxembourg with an indicator if the worker is posted abroad during the employment period

Notes: The Figure summarizes the collected administrative datasets on the European mobility policy of posting and used for the empirical analysis. More details on the datasets can be found in the text. Each dataset on posting is also described in details in one dedicated appendix by dataset.

Table A.2: **Administrative Datasets on labor Markets in Receiving and Sending Countries**

Dataset	Source	Period	Description
Datawarehouse	BCSS	2007-2019	Administrative matched employer-employee data allowing to follow over time the universe of employment periods of the universe of workers hired in Belgium, that can be merged to the entire set of social security registries in Belgium.
AA	NBB	2007-2019	Balance sheets firm data from corporate tax returns covering the universe of non financial corporations established in Belgium
DADS Postes	INSEE	1970-2018	Administrative matched employer-employee data covering the universe of job spells in France
FICUS/FARE	DGFIP	2000-2017	Universe of corporate tax returns for the universe of firms established in France
IGSS	IGSS	2022-2017	Administrative matched employer-employee data allowing to follow over time the universe of employment periods of the universe of workers hired in Luxembourg, that can be merged to the entire set of social security registries in Luxembourg.
CBHP	BoP	2006-2017	Universe of corporate tax returns for the universe of firms established in Portugal

Notes: The Figure summarizes the collected administrative datasets on workers and firms in receiving and sending countries. More details on the datasets can be found in the text.

Table A.3: **Pre-Shock Exposure to Posting and Pre–Shock Local Labor Markets Demographics**

Pre-reform Level	Bottom 20 Exposure	Top 20 Exposure
Share of blue collar workers	24%	28%
Share of manufacturing employment	16%	18%
Share of Foreign Born	11.2%	7.9%
Share of Working Age Pop in Employment	65%	64%
Working Age Population (thousands)	490	407
Share with an International Border	6%	38%
Pre-reform Posting Imports per Worker	.01 %	.4%

Notes: This Table shows some province demographics by pre-reform exposure to posting measured by pre-liberalization imports of posting services per worker.

Table A.4: **Imports of Posting Services Per Worker, France**

	Imports of Posting Services per worker (in %)	
	Before Liberalization	After Liberalization (2005-2015)
Mean	.07	.52
Std deviation	.13	.51
Median	.03	.34
25th percentile	.01	.22
75th percentile	.06	.58

Notes: This table summarizes province-level exposure to posting services before the liberalization of posting (first column) and after (second column) in France.

Table A.5: **Zero First Stage Test**

	Δ, 1993-2003			
	Working Age Pop	Exposed Emp	Sheltered Emp	Unemp
	(1)	(2)	(3)	(4)
Pre-reform Exposure to Posting	0.005	.0134	.004	-.001
	(.00349)	(.0123)	(.005)	(.008)
Observations	94	94	94	94

Notes: This Table tests the correlation between pre-reform local labor markets outcomes with the measure of pre-reform exposure to imports of posting services.

Table A.6: **Pre-Reform Exposure to Posting: First-Stage**

Dependent variable	Post-Reform Exposure to Posting				
	Baseline 2003 Exposure	2000 Normalization	Distance to NMS	Exposure Leave-Out	Predicted Exposure
	(1)	(2)	(3)	(4)	(5)
Rank-Rank	.47***	0.20***	-0.34***	.32***	.45***
	(.04)	(.09)	(.10)	(.09)	(.09)
Observations	94	94	94	94	94
Log-Log	.29***	.28***	-2.075***	.294***	.39***
	(.065)	(.064)	(.539)	(.083)	(.060)
Fstat	19.49	19.81	14.10	12.49	44.2
Anderson-Rubin	15.36	15.41	21.8	15.9	38.9
Observations	94	94	94	94	94

Notes: *p<0.10, **p<0.05, ***p<0.01. Robust standard errors in parentheses. This table summarizes the predictive power of measures of pre-reform French provinces' exposure to the nation-wide 2004 liberalization. The dependent variable is province-level exposure to posting after the liberalization, measured as average province-level posting imports in 2005-2015 per pre-reform total employment. The baseline measure of pre-reform exposure is a province imports of posting services per worker e_p^{pre} computed following Equation (1.2). Column (2) uses 2000 employment normalization to avoid having the same denominator in both variables. Column (3) uses geographic distance to NMS countries gaining access to the French labor market in 2004 as a predictor for posting imports after the liberalization. Column (4) computes initial imports of posting services by province corrected with a leave-one-out approach as explained in the text. Column (5) uses predicted posting imports per pre-reform worker $\hat{e}_p^{post}$ as an alternative predictor for posting exposure. It is computed by interacting the share of workers posted in a sector and in a province before the reform with national sectoral inflows of posted workers after the reform.

Table A.7: **Effect of Posting Exposure on Receiving Country Employment: Robustness to Baseline Specification**

Dependent Variable: Change in exposed employment/pop, 2003-2015 (%pts)						
	(1)	(2)	(3)	(4)	(5)	(6)
Δ Posting Imports	-1.560***	-1.604***	-.529**	2.911***	-1.173***	-1.588***
	(.299)	(.287)	(.258)	(1.04)	(.329)	(.345)
Observations	94	94	94	94	94	94
Instrument	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline
	(7)	(8)	(9)	(10)	(11)	(12)
Δ Posting Imports	-2.192***	-1.571***	-1.571***	-1.992***	-1.650***	
	(.710)	(.331)	(.335)	(.599)	(.351)	
Observations	94	94	94	94	94	
Instrument	Distance	2000 Norm	1990 Shares	Leave-Out	Predicted Inflows	
Fstat	14.10	19.81	20.15	12.49	44.2	

Notes: *p<0.10, **p<0.05, ***p<0.01. This table repeats the baseline specification of Panel B, table 1.3, with additional specifications and robustness. Column (1) uses pre-reform weighting instead of pre-reform population. Column (2) clusters the standard errors are the region level (there are 21 regions in France). Column (3) excludes industrial services from the estimation. Column (4) uses posting exposure per worker in percentage points rather than log as a regressor. Column (5) controls for inflows of standard migrants after the reform.

Table A.8: **Robustness: Instrumenting with Geographic Distance to NMS**

Dependent Variable: Change in exposed employment/pop, 2003-2015 (%pts)			
	(1)	(2)	(3)
Δ Posting Imports	-1.604***	-1.571***	-1.650***
	(.338)	(.331)	(.351)
AKM standard errors	(.045)	(.033)	(.409)
Observations	94	94	94
Instrument	Baseline	2000 Norm	Predicted

Notes: *p<0.10, **p<0.05, ***p<0.01. This table repeats the baseline specification using **?** inference for standard errors.

Table A.9: **Robustness: Instrumenting with Geographic Distance to NMS**

Dependent Variable: Change in exposed employment/pop, 2003-2015 (%pts)

	Post-reform (2003-2015)			Falsification Test 2000-2003
	(1)	(2)	(3)	(4)
Δ log Posting Imports/worker	-2.192***	-1.889***	-2.664***	-.443
	(.710)	(.683)	(.921)	(.313)
Observations	94	94	94	94
Fstat	14.10	9.23	14.80	14.10
Δ Posting Imports/worker (% ppts)	-2.722***	-4.123***	-3.360***	-.810
	(1.092)	(.683)	(1.280)	(.532)
Observations	94	94	94	94
Fstat	7.8	4.2	10.8	7.8

Notes: *p<0.10, **p<0.05, ***p<0.01. This table repeats the baseline specification displayed in table 1.3 using geographic distance to NMS countries as an alternative instrument for post liberalization imports of posting services.

Table A.10: **Exporters and Employment in Non-Tradable Services Sectors**

Mobility-Dependent Sector	% of non-financial corporations (1)	% of salaried employment (2)	% of firms that export (3)
Roofing activities	.03	.03	17.7
Test drilling and boring	.02	.03	5.9
Construction of water projects	.01	.04	12.5
Construction of railways	.01	.04	19.5
Demolition	.03	.04	6.5
Plastering	.1	.05	9.8
Construction Utility Projects for fluids	.05	.08	6.2
Other Building Completion	.2	.1	15
Installation of Industrial Machinery and Equipment	.1	.12	23.4
Site preparation	.15	.13	2.9
Painting and glazing	.2	.1	6.7
Floor and wall covering	.3	.2	20.1
Construction of utility projects for electricity	.05	.2	13.7
Joinery installation	.4	.2	13.6
Installation of conditioning air	.3	.2	8.4
Installation of plumbing	.4	.2	5
Repair of machinery	.2	.2	13.9
Other construction installation	.2	.3	11
Construction of bridges	.01	.35	29
Other misc construction activities	.4	.4	11
Construction of roads	.09	.7	11
Construction of other civil engineering projects	.4	.7	6.7
Electrical installation	1	.9	5.4
Freight transport by road	2.0	2.4	29.7
Temporary employment agency activities	.1	3.4	34
Construction of residential and non residential buidings	5.7	3.9	6.2
Total Non-Tradable Services Sectors	12.6	15.3	11.5

Notes: This Table shows describes firms in mobility-dependent services sectors. The estimations are based on detailed administrative firm-level balance-sheets data covering the universe of non-financial companies operating in Portugal merged with exhaustive information on trade in goods and services at the company-level.

Table A.11: **Exporters and Employment in Manufacturing Sectors**

Manufacturing Sector	% of non-financial corporations (1)	% of salaried employment (2)	% of firms that export (3)
Bleaching and dyeing	.02	.16	16.5
Manufacture of medicaments	.02	.17	44.3
Processing and preserving of poultry	.01	.17	44.7
Sawmilling of wood	.12	.17	27.1
Treatment of metals	.12	.19	11.3
Manufacture of parts of footwear	.08	.19	28.1
Manufacture of marble	.20	.20	40.8
Processing and preserving of meat	.03	.20	35.0
Cotton-type weaving	.02	.20	52.1
Manufacture of motor vehicles	.01	.21	28.7
Operation of dairies and cheese-making	.06	.2	29.2
Support activities for crop production	.22	.22	2.7
Production of meat	.09	.25	40.0
Machining	.22	.26	18.9
Growing of vegetables	.30	.26	8.2
Manufacture of pastry and cakes	.22	.26	7.7
Manufacture of other metal products	.19	.28	37.6
Manufacture of textile	.14	.31	34.0
Manufacture of wine	.2	.32	44.5
Mixed farming	.8	.33	9.8
Manufacture of underwear	.07	.34	41.9
Manufacture of metal moulds	.16	.38	39.6
Other printing	.30	.39	29
Manufacture of plastic products	.13	.40	53.2
Manufacture of doors	.58	.51	28.9
Manufacture of metal structures	.22	.54	28.2
Manufacture of vehicles' parts	.06	.84	49.9
Manufacture of bread	.0.67	1.0	2.9
Manufacture of footwear	.42	1.6	31.5
Manufacture of ready-to-wear outerwear	.76	2.2	21.9
Aggregate Manufacturing	12.3	23.7	23.3

Notes: Notes: This Table shows describes firms in manufacturing sectors. The estimations are based on detailed administrative firm-level balance-sheets data covering the universe of non-financial companies operating in Portugal merged with exhaustive information on trade in goods and services at the company-level.

Table A.12: **Exporters' Premium in Manufacturing vs Non-Tradable Service Trade**

	Exporters vs Non Exporters		Exporters
	Manufacturing	Non Trad. Services	Manufacturing vs Non Trad. Services
	(1)	(2)	(3)
Log Turnover	1.57***	.84***	.68***
	(.01)	(.01)	(.01)
Log Employment	.91***	.63***	.55***
	(.01)	(.01)	(.01)
Log Wage	.18***	.22***	-.04***
	(.00)	(.00)	(.00)
Log Capital/Worker	.64***	-.14***	.48***
	(.01)	(.01)	(.01)
Log Payroll/Turnover	-.32***	.04***	-.19***
	(.00)	(.00)	(.00)
Log EBT/Worker	.15***	-.02*	.12***
	(.01)	(.01)	(.01)
Fixed effects	Year×Sector×Prov	Year×Sector×Prov	Year×Prov

Notes: *p<0.10, **p<0.05, ***p<0.01. This Table shows differences in firms exporting goods in standard manufacturing sectors and firms providing non-tradable services listed in Table A.10. The estimations are based on detailed administrative firm-level balance-sheets data covering the universe of non-financial companies operating in Portugal between 2006 and 2017 merged with exhaustive information on trade in goods and services at the company-level. A firm is defined as an exporter in a given year if exporting manufacturing goods or non-tradable services this year. Column (3) summarizes average differences between exporters' outcomes in manufacturing vs non-tradable services sectors. It shows the estimate from a OLS regression of log exporters' outcomes on a dummy that is equal to one if the exporter is operating in the manufacturing service, controlling for year×province fixed effects, and clustering standard errors at the firm level. Columns (1) and (2) summarizes the average differences between exporters and non-exporters within respectively manufacturing and non-tradable services industries. It shows the estimate from a OLS regression on log firms' outcomes on a dummy equal to one if the firm is exporting in that given year, controlling for year×province fixed×5digit sector fixed effects, clustering standard errors at the firm level, run separately on all manufacturing firms (Column (1)) and all mobility-dependent services suppliers (Column (2)). Column (1) estimating the exporter premium in manufacturing is comparable in spirit with the estimates produced by **?**.

Table A.13: **Export Exposure in Manufacturing vs Non-Tradable service trade**

	Manufacturing	Non Trad. Services
	(1)	(2)
Exports in Turnover	25%	45%
% Shifting Full Activity Abroad	3%	19%
% Exporting in Founding Year	9%	21%
Average Export Duration (years)	5	3.2
% Permanently Exporters	41%	37%

Notes: This Table summarizes descriptive statistics on exports of manufacturing and non-tradable services, based on detailed administrative firm-level balance-sheets data covering the universe of non-financial companies operating in Portugal between 2006 and 2017 merged with exhaustive information on trade in goods and services at the company-level.

Table A.14: **Magnitude of Provision of Services Through Posted Workers in the EU**

A- Overall Internationally Mobile Service Trade Within-EU (2017)					
	Posting forms (thousands)	Posting flows (billion euros)			
Within-EU	1,730	280			
B- Worker and Firm Level Exposure					
	Sending firms per year	Ever sending firms	Employees at sending firms per year	Sent posted workers per year	Period
Portugal	5,938	19,437	181,549	-	2006-2017
Luxembourg	1,884	6,891	137,272	11,433	2004-2019
	Using firms per year	Ever using firms	Employees at using firms per year	Posted workers per year	Period
France	12,780	-	3,358,236	227,991	2017-2019
Belgium	9,300	23,305	-	236,791	2014-2019

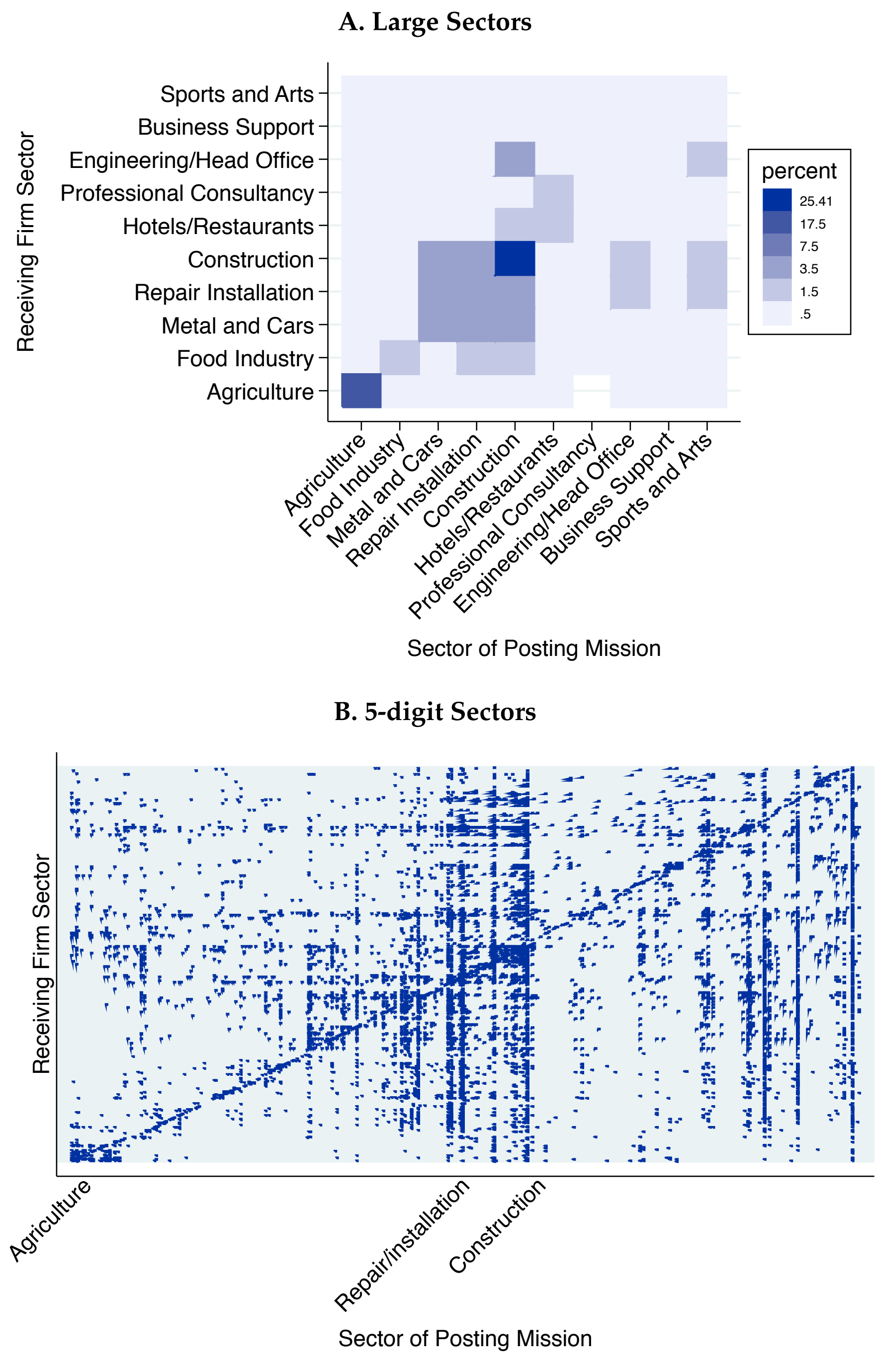
Notes: The table summarizes descriptive statistics on the magnitude of posting of workers in the European Union. The top panel describes posting flows at the EU level. The number of posting forms issued in 2017 is based on mandatory social security forms that posted workers must hold when providing services abroad. The monetary value associated with these flows is computed by applying the standard balance of payment methodology (MSITS 2010) to service trade flows in the entire EU by BPM6 sectors, which allows me to recover provision of services through the movement of natural persons (mode 4). The bottom panel is based on country-level micro registries on postings. Data for postings from Portugal are based on exhaustive firm-level tax declarations merged with information on services provided in another EU country from 2006 to 2017. Data on postings from Luxembourg are based on exhaustive firm-level payroll declarations covering all job spells in Luxembourg merged with information on services provided in another EU country from 2004 to 2020. Data for postings to France are based on exhaustive posting declarations filed by foreign suppliers performing services in France merged with French-linked employer-employee data. Data for postings to Belgium are based on exhaustive posting declarations filed by foreign suppliers performing services in Belgium merged with Belgian-linked employer-employee data.The number of sending (using) firms relates to the number of firms that export (import) posting each year, while the number of never-sending (using) firms relate to the unique number of firms that exported (purchased) posting services during the period of observation.

A.2 Industry-Level Gains From the Liberalization: The Truck Drivers Example

To further document the aggregate industry-level gains from the posting policy, I take advantage of unique European data on economic activity in one sector heavily affected by the posting policy: road transport.[1] After 2004, truck drivers from NMS were granted the right to perform their activity in other EU countries. The data allows me to observe precisely measured economic performance in that sector (million-tonne per kimeter) in each European Member State, and conveniently disaggregates economic activity between services performed domestically or in other member states' territories. Figure A.23, Panel A, shows the evolution of truck driving services performed by European countries in other countries' territory, before and after the liberalization of posting. NMS export of driving services started to increase dramatically after they gain the right to post workers abroad. For instance, exports of road transport services from firms located in Poland has been multiplied by 5 between 2004 and 2017. Figure A.23, Panel B, shows that as they gain access to foreign markets, NMS countries increase their overall economic activity in the treated sector. At the same time, economic performance of firms located in other countries such as France, Belgium or Austria, starts to decrease following NMS entry. It thus exemplifies the large redistribution of market shares in formerly non-tradables sectors that followed the expansion of the posting policy to low-wage countries.

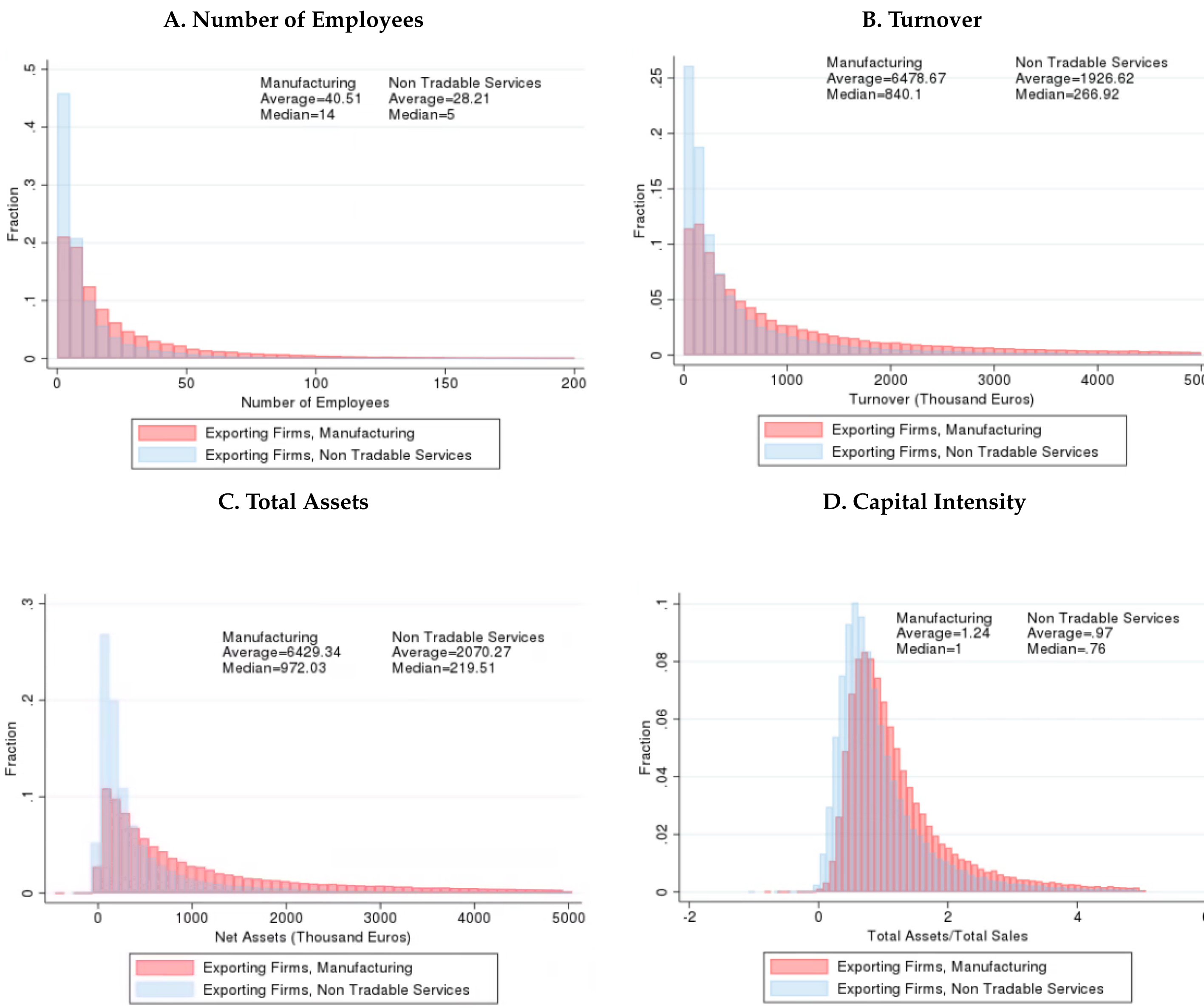
[1]Unfortunately, there is not harmonized data on economic performances in other sectors like construction. I thus focus on the road transport sector as Eurostat provides very detailed information on economic activity in that sector.

Figure A.44: **Sector of Using Firm and Offshored Task**



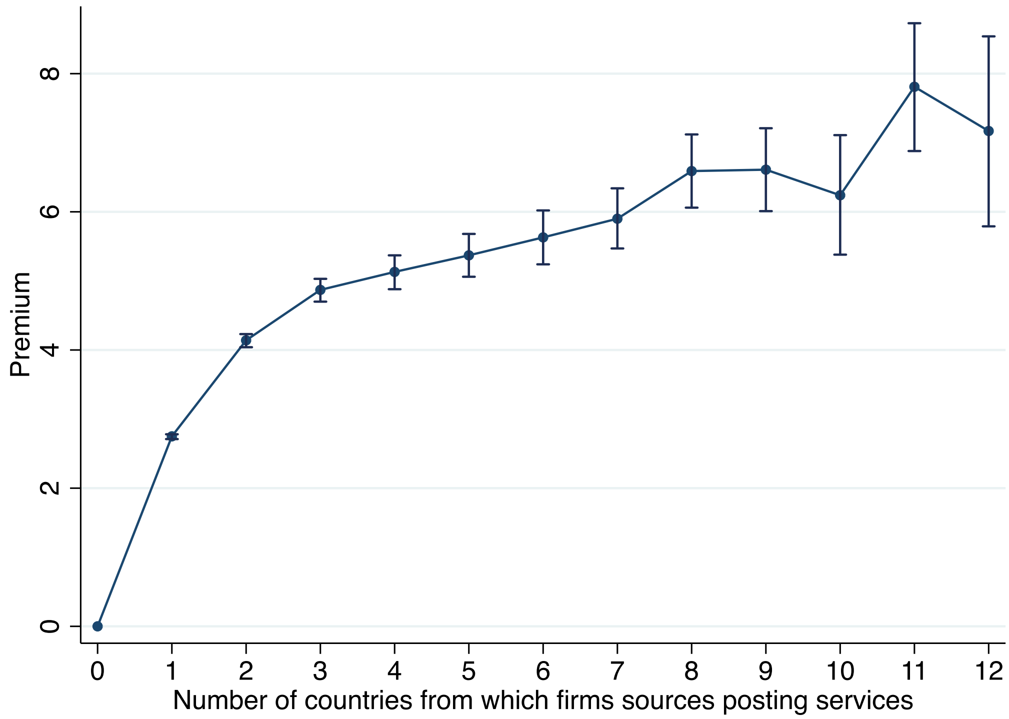
Notes: This Figure shows the sectoral decomposition of posting missions performed in the second largest importer of posting services: France. I use the universe of mandatory posting declarations filed by foreign suppliers that send posted workers in the French territory (DPD/SIPSI dataset) from 2016 to 2020. Since 2019, it is mandatory for foreign suppliers to report the 5-digit NACE code of the mission performed by foreign employees in France's territory. The identifier number of the using firm reported in the posting declaration further allows to recover the 5-digit NACE code of using firms' activity. I use these two informations to show the relationship between using firms' activity and type of activity offshored through posted workers, aggregated at the 2-digit level in top panel, and 5-digit level for bottom panel. Table A.17 and Table A.15 shows the underlying numbers for top posting sectors.

Figure A.45: **Firms Exporting Through Posting Differ from Standard Exporters**



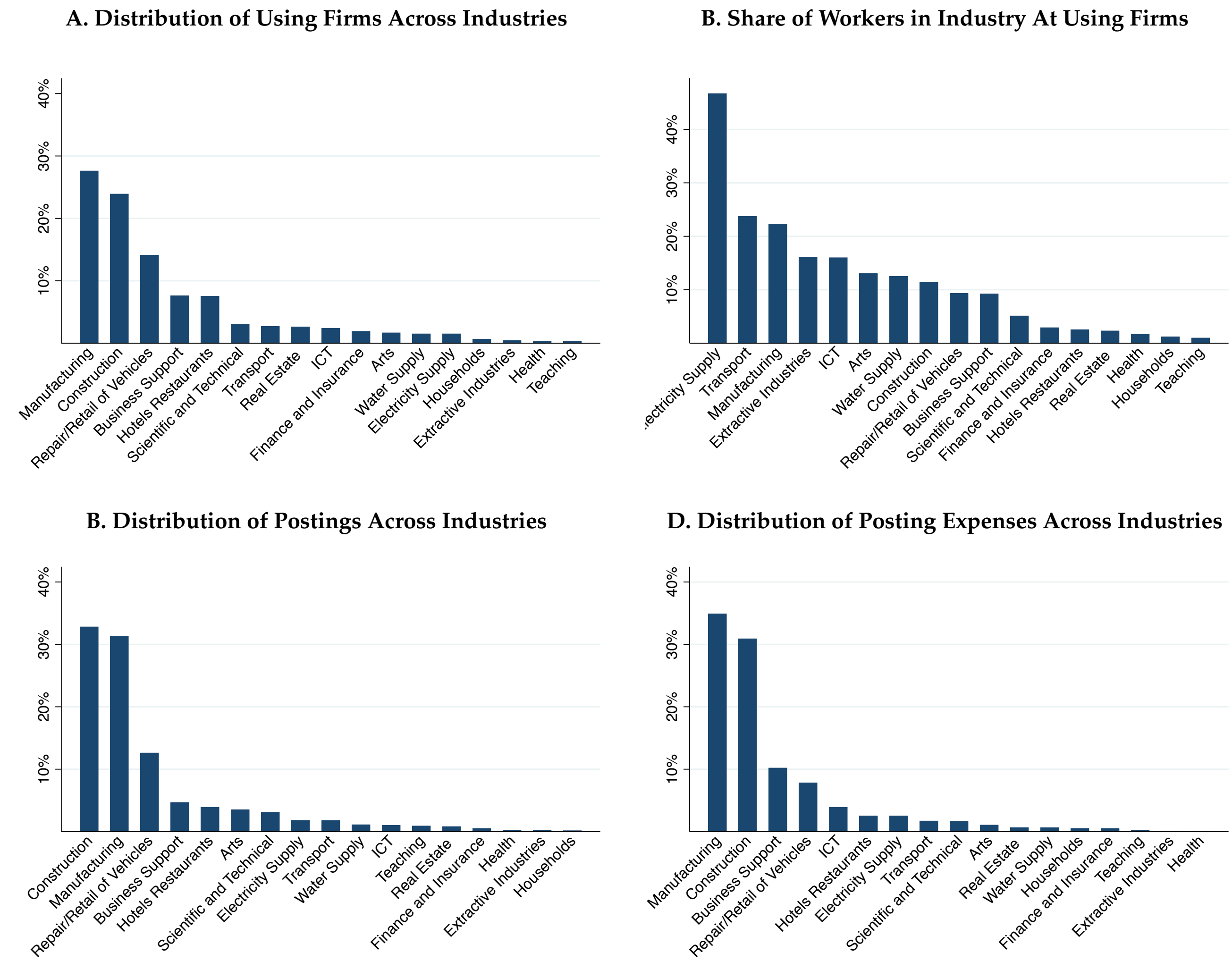
Notes: This figure compares characteristics of firms exporting standard manufacturing goods and non-tradable services in one of the main sending country in Europe, Portugal. It is based on exhaustive firm-level tax data covering all non-financial corporations operating in Portugal merged with exhaustive information on trade in goods and services transactions from 2006 to 2017. I use this information to track the 5,938 (11%) services suppliers that performed their activity in another EU country each year during this period and the 19,437 firms that exported a service through posted workers in EU at least once. Exporters of non-tradables operate in sectors listed in Table A.10. The graph shows the distribution of employees (Panel A), turnover (Panel B), assets (Panel C), and capital intensity (Panel D) for firms in manufacturing sectors (red) against firms in non-tradable sectors (blue), in the year in which these firms export manufacturing goods or non-tradable services. Table A.12 presents the regression equivalent of these graphs as well as exporter premium estimates. Data are described in Appendix A.4.

Figure A.46: **Size Premium and Number of Sourcing Countries For Posting Services**



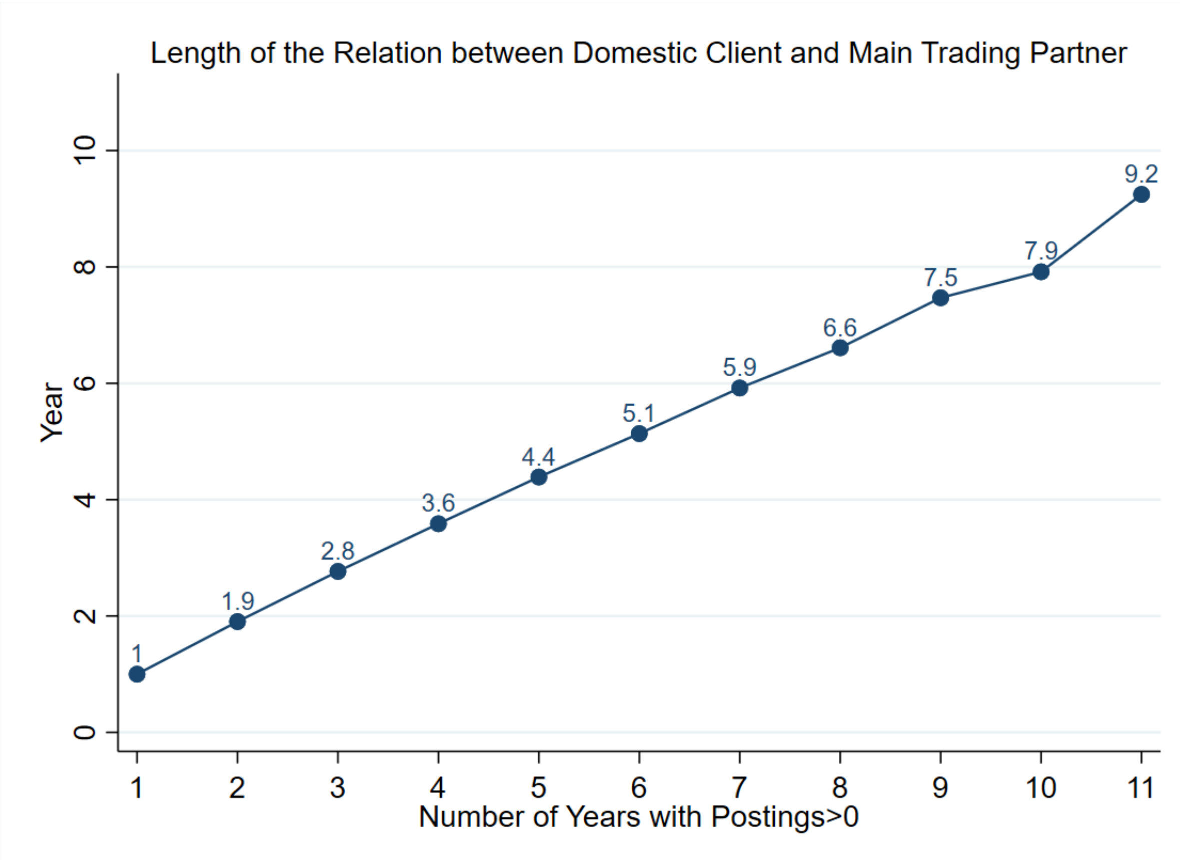
Notes: The Figure shows the size premium related to the number of sourcing countries for posting services in the second largest importer of posting services: France. I use the universe of mandatory posting declarations filed by foreign suppliers posting workers to France (DPD/SIPSI dataset) from 2017 to 2020. I select the number of firms that purchased a posting services at some point in 2018.

Figure A.47: **Industry Shares of On-Site Offshoring Using Firms and Workers**



Notes: The figure shows distribution of domestic workers and using firms across industries and posting using status in the second importer of posting services: France. I use the universe of mandatory posting declarations filed by foreign suppliers posting workers to France (DPD/SIPSI dataset) in 2018 that I merge with exhaustive tax returns coverting the universe of French companies excluding the one operating in the agricultural sector (FICUS/FARE dataset).

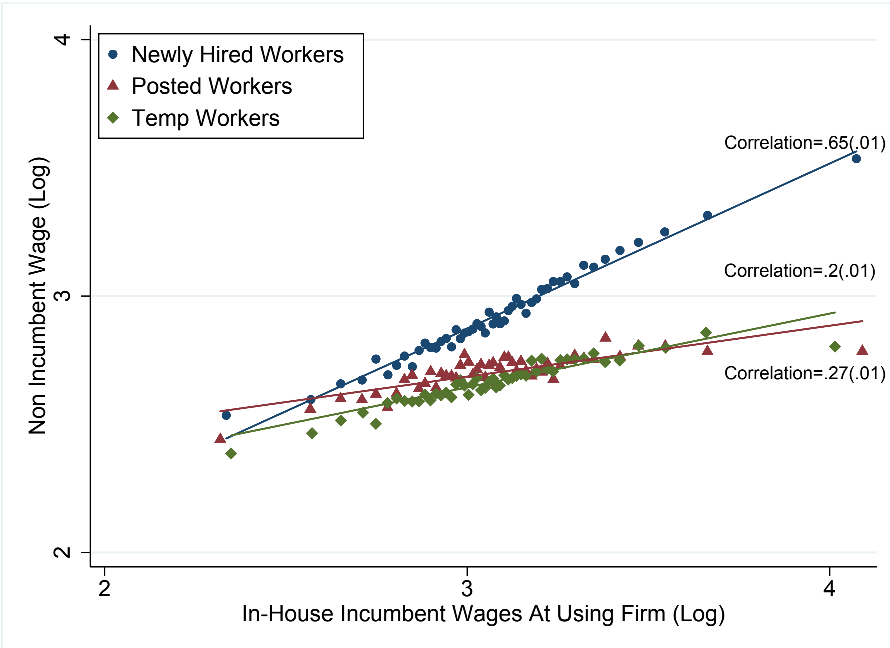
Figure A.48: **Stickiness in Relationship Between Receiving Firms and Trading Partner**



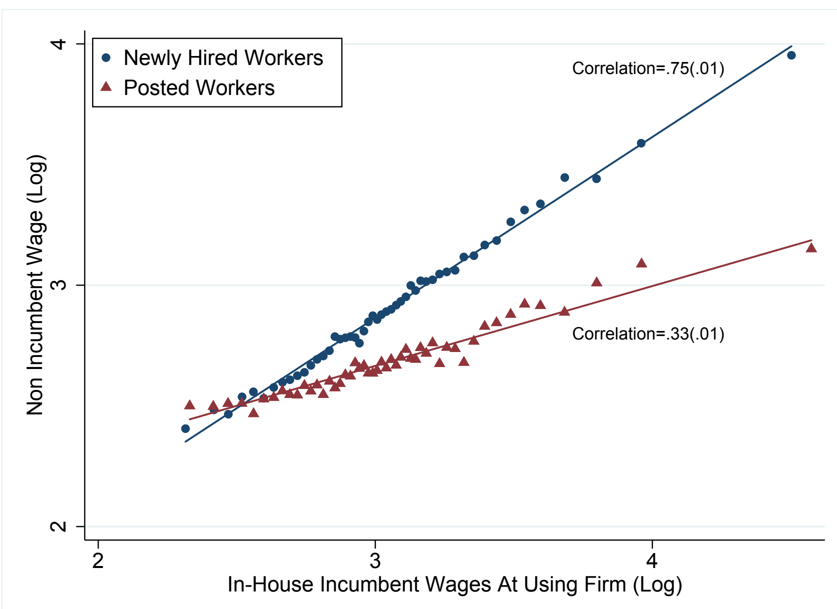
Notes: This figure shows the length of the relation between Belgian clients and their main supplier of posting service over time.

Figure A.49: **Do Using Firms Share Pay Premia With Posted Workers?**

A. Relationship Between In-House Workers and Posted Workers Wages

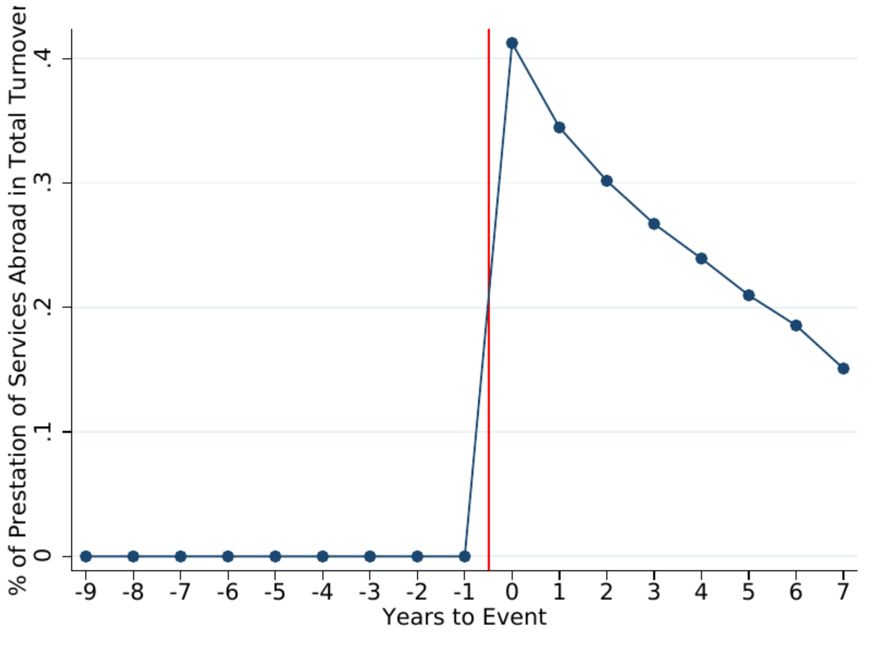


B. Raw Correlation (No 5-Digit Sector Residualization)



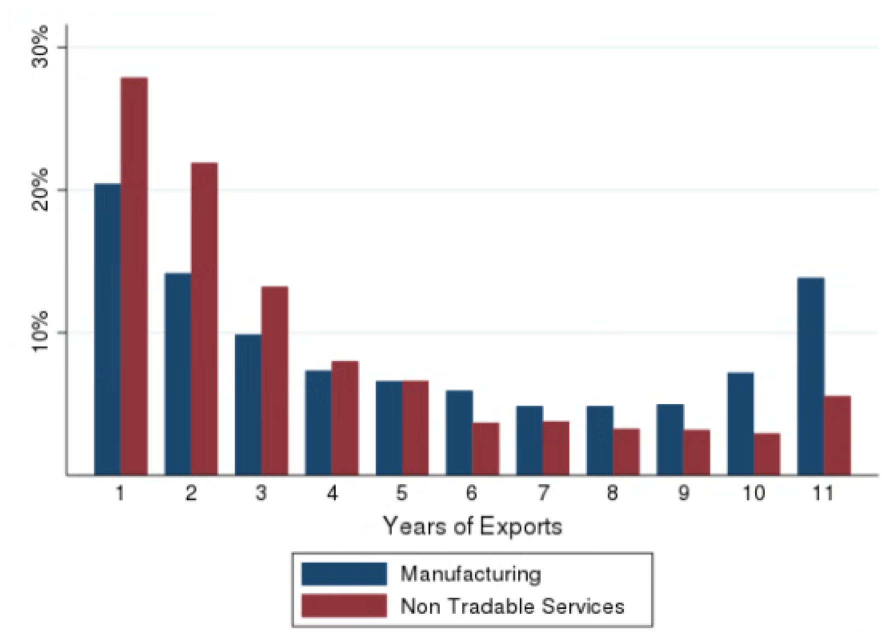
Notes: This Figures compares posted and domestic workers' wage *within a workplace* in the second largest importer of posting services: France, repeating Figure 1.11 with alternative specifications. Panel A completes Figure 1.11.A by adding the correlation between (domestic) temporary agency workers and incumbent workers at using firms. Panel B completes Figure 1.11.A by showing the raw correlation between incumbent wages and posted workers' wages (red plot) and newly hired domestic workers (blue dots), without adjusting for 5-digit sectors fixed effects. See footnote under Figure 1.11 for sample selection and specification details.

Figure A.50: **First Provision of Services Abroad Event**



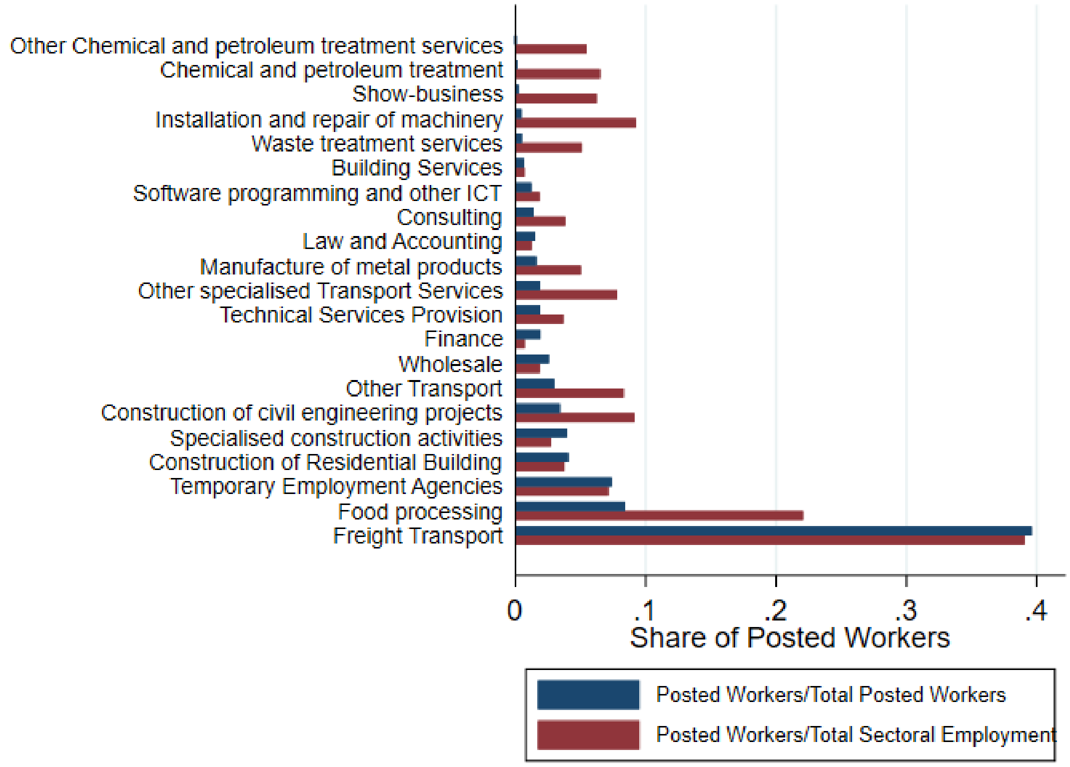
Notes: Notes: This Figure studies how posting affects sending firms located in Portugal, one of the main supplier of posting services in Europe. I use exhaustive administrative tax records of Portuguese firms merged with administrative records of services performed in another EU country from 2006 to 2017 to select the 4,151 firms -with a median of more than 3 employees over the period- that start posting workers abroad for the first time between 2010 and 2015. The figure describes the magnitude and persistence of the first provision services abroad event for Portuguese firms. It plots the average provision of services performed in another EU country in firm-level total sales before and after the first provision of services abroad. Sample and descriptive statistics can be found in Appendix A.4 and Appendix **??**. The distribution of the 4,151 baseline events by treatment duration is described in Table A.20.

Figure A.51: **Export Duration for First Exporters of 2007**



Source: This Figure compares the distribution of export duration for first that start exporting in 2007 in manufacturing versus non-tradable services. The dataset used is a detailed administrative firm-level balance-sheets data covering the universe of non-financial companies operating in Portugal between 2006 and 2017 merged with exhaustive information on trade in goods and services at the company-level.

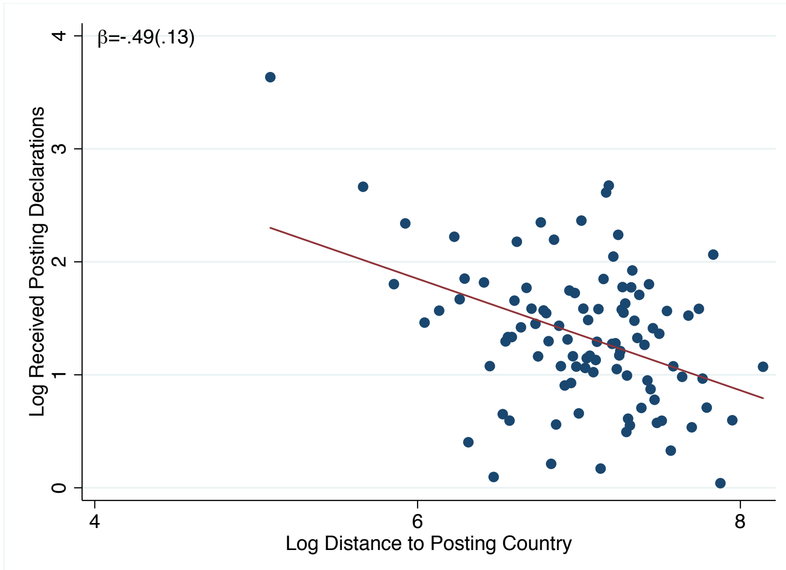
Figure A.52: **Exports of Posting Missions From Luxembourg**



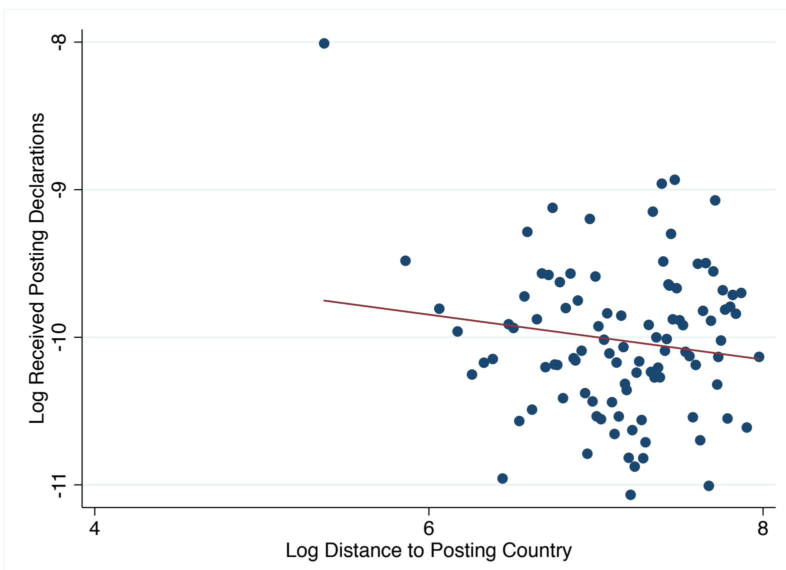
Notes: The Figure shows the amount of posting missions from Luxembourg based on the IGSS dataset.

Figure A.53: **Link Between Geographic Distance And Posting Exposure Lowers Over Time**

A. Distance and Posting Inflows, 2005

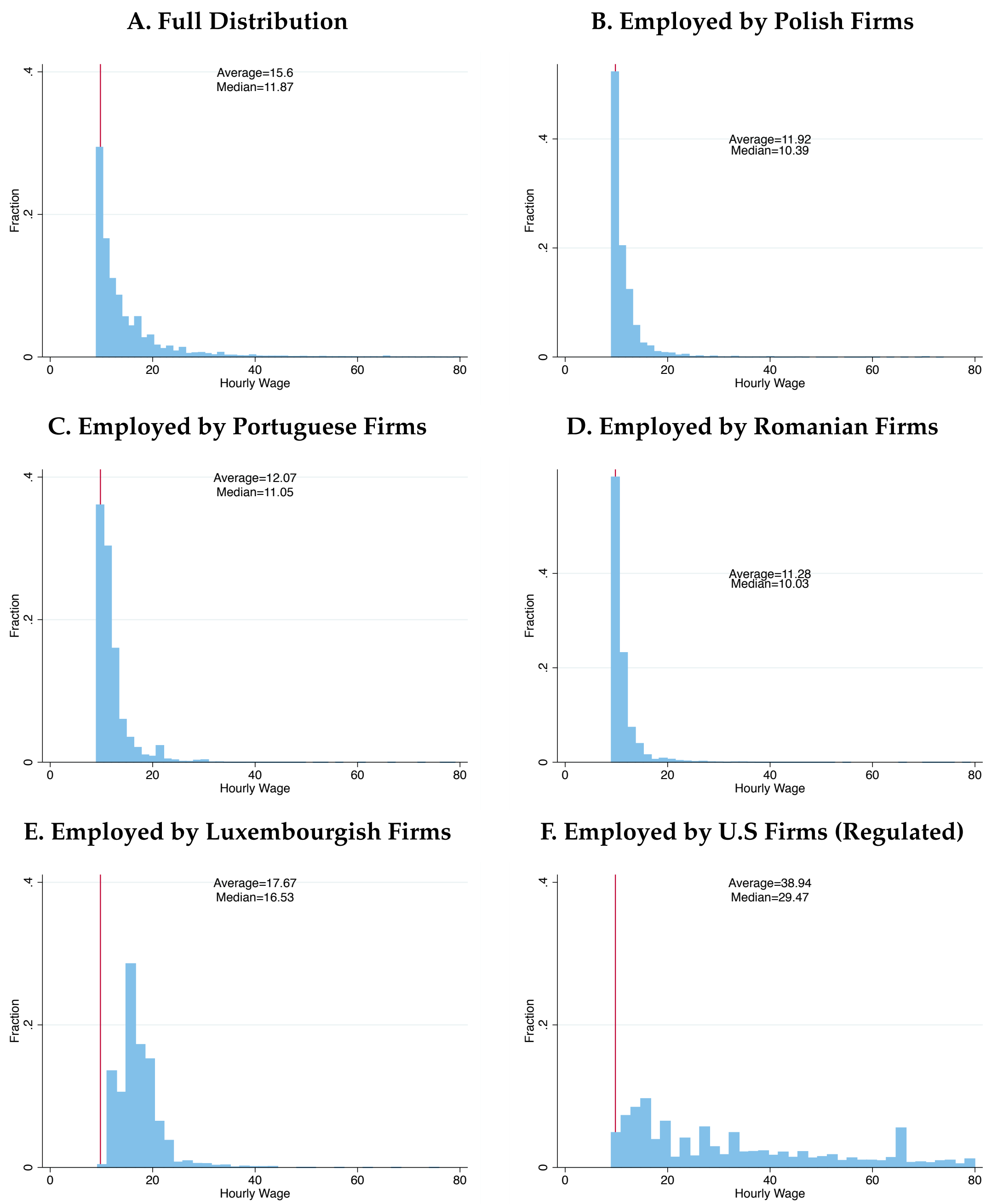


B. Distance and Posting Inflows, 2015



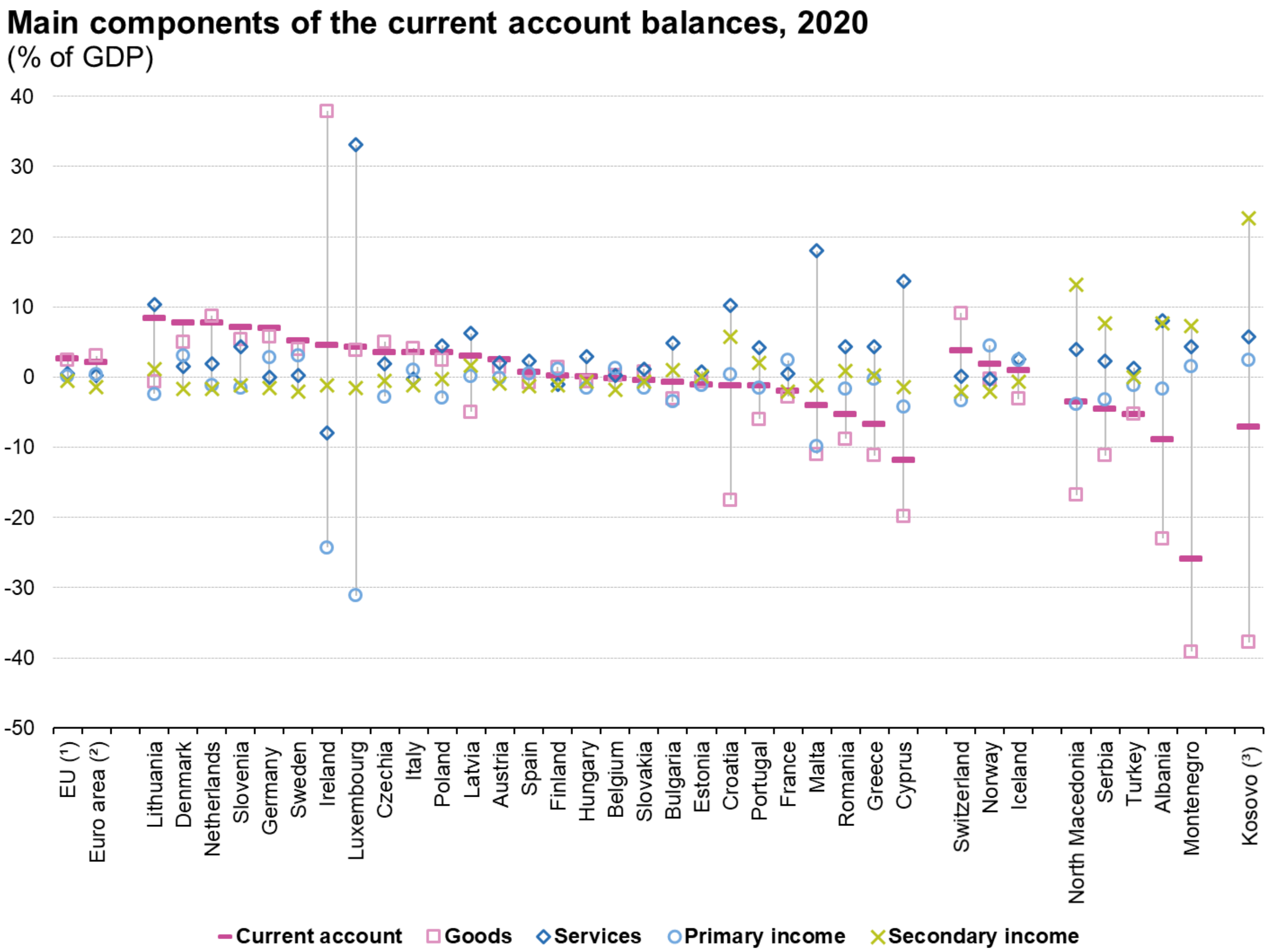
Notes: The Figure shows the relationship between distance to posting country and number of posting received from this country for each French province and each origin country.

Figure A.54: **Earnings of Posted Workers Performing Services in France**



Notes: The Figure plots the distribution of hourly euro wage received by workers posted to France in 2018 and is based on the SIPSI dataset described in details in A.5.

Figure A.55: **Current Account, Services and Goods, Europe**



Data for Bosnia and Herzegovina not yet available.

(¹) EU vis-à-vis extra-EU.

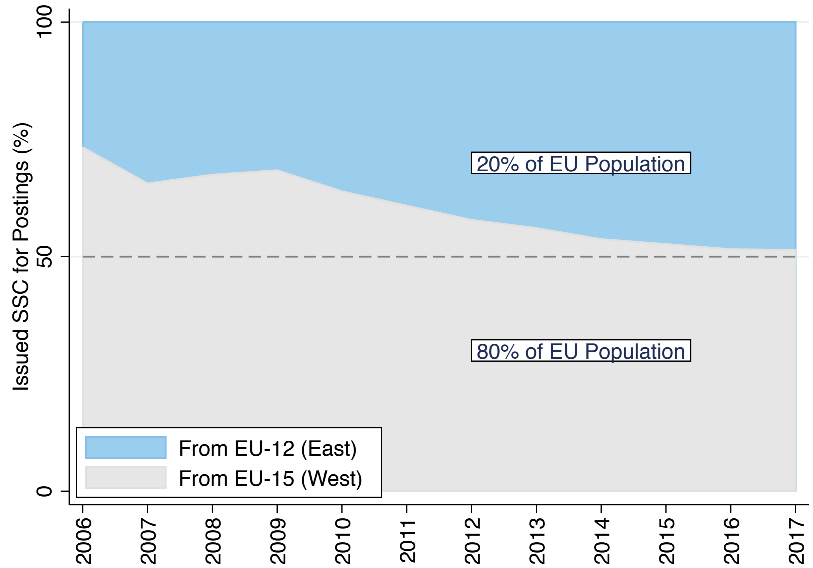
(²) Euro area vis-à-vis extra-euro area.

(³) This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.

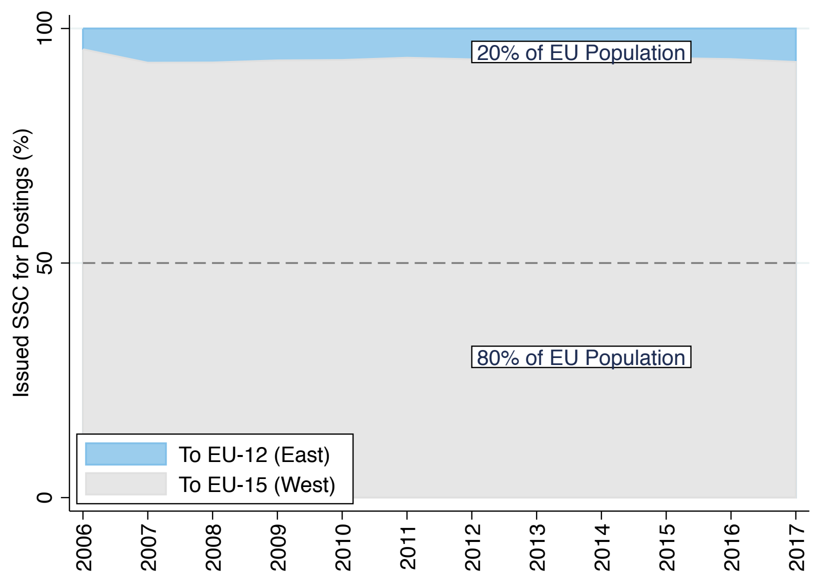
Source: Eurostat (online data code: bop_gdp6_q)

Figure A.56: **Posting of Workers within EU**

A. Posting by Sending States



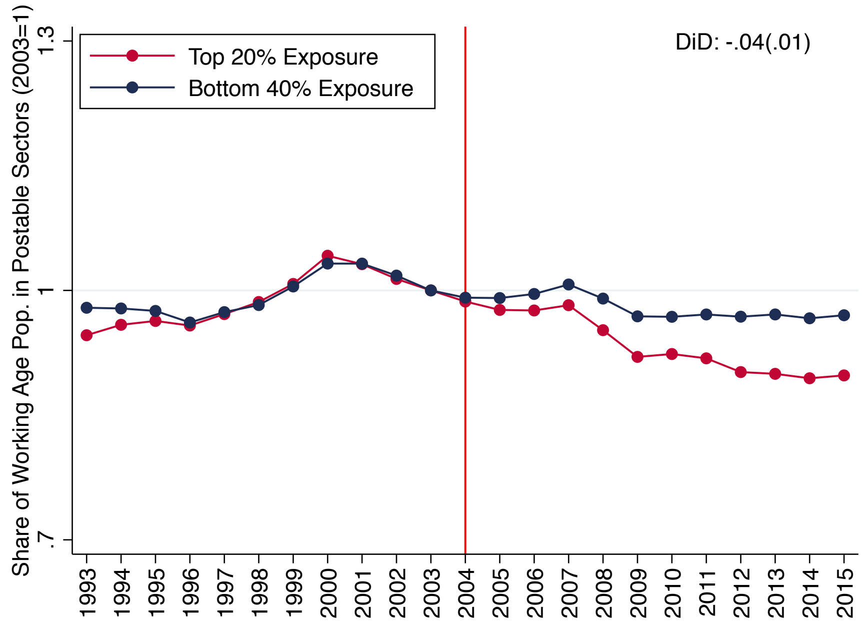
B. Posting by Receiving Member States



Notes: The Figure shows the decomposition of posted workers flows within the EU by sending (top panel) and receiving (bottom panel) member states. The EU-12 includes Poland, Slovakia, Slovania, Czech Republic, Lithuania, Latvia, Malta, Cyprus, Hungary, Bulgaria, Romania and Croatia. The EU-15 includes France, Spain, Portugal, Italy, United Kingdom, Germany, Greece, Austria, Denmark, Luxembourg, Netherlands, Belgium, Finland, Sweden and Ireland. Data on posted workers flows build on social security forms issued for postings and collected from the European Commission for the period 2006-2017 at the origin-destination level.

Figure A.57: **Employment Effects: Alternative Pre-Reform Exposure Measures**

A. Leave-out Exposure



Notes: The figure studies the effect of posting on domestic employment in the second largest importer of posting services: France. I use the dataset on all posting declarations filed by foreign suppliers sending posted workers to France aggregated at the province-year-sector from 2000 to 2015 (DPD/SIPSI), merged with administrative data on French domestic employment and working age population at the province-year-sector from 1990 to 2015 from INSEE. The aggregate DPD/SIPSI dataset builds on yearly province-level administration (DIRECCTE) reports to the French ministry of labor of the number of received posting declarations each year. In 2004, France lifted entry restrictions for workers posted from 10 Eastern European countries, leading to permanent increased import exposure in some sectors through posting (Figure **??**). Province-level exposure to the 2004 shock is defined by exposure to the shock before the reform, in 2003. Panel A shows the evolution of the share of domestic workers in exposed sectors, before and after 2004, in provinces with low and high exposure to the shock. Panel B shows the counterparts for the share of domestic workers in sheltered sectors, such as health or administrative support.

A.3 Data Appendix: E101/A1 Dataset

The E101/A1 dataset is based on social security forms for posting issued in the EU for the period 2005-2017. Before being sent abroad by their company, European posted workers must request a proof that they stay affiliated to their origin country social security system through a certificate E101, that has been renamed PD A1 in 2010. This certificate concerns the social security legislation which applies to a person and confirms that this person has no obligations to pay contributions in another Member State. This social security forms finds its legal ground in the European regulation on social security coordination (EC 883/2004)

The social security forms for posting are issued by social security organizations and are compulsory before any posting of workers within the European Union. The form contains many information on the posting mission such as origin and destination countries, the length of the work mission, the employment status of the individual (employed or self-employed) and sector of activity of the posting mission performed by the mobile employee. Importantly, the numbers on E101/A1 forms have to be interpreted as posting

Table A.15: **Proximity between using firms 5-digit activity and purchased posting service**

Receiving sector (% of all postings)	Offshored Task (% of Sectoral Overall On-site Offshoring)	
Other specialised construction 8.2%	Other specialised construction 39.2%	Construction of buildings 38.6%
Installation of machinery 4.2%	Professional and scientific 16.4%	Installation of machinery 13.2%
Wholesale of machinery 3.6%	Other specialised construction 20.5%	Other professional services 13.2%
Construction of buildings 3.2%	Construction of buildings 67.8%	Other specialised construction 11.4%
Engineering and technical 3.1%	Other specialised construction 16.9%	Other professional services 12.7%
Manufacture of vehicles 2.7%	Manufacture of vehicles 61.9%	Other professional services 4.9%
Growing of vegetables 2.1%	Growing of crops 45.3%	Growing of vegetables 23.7%
Activities of head offices 1.5%	Petrol treatment 54.24	Other professional services 6.7%
Joinery installation 1.4%	Construction of buildings 28.5%	Joinery installation 28.3%
Manufacture of metal 1.4%	Other specialised construction 21.7%	Manufacture of metal 15.5%
Repair of machinery 1.3%	Manufacture of refractory 27.7%	Other specialised construction 11.2%
Building of ships 1.3%	Building of ships 22.7%	Other specialised construction 15.7%
Electrical installation 1.3%	Construction of buildings 22.3%	Electrical installation 17.1%

Notes: This table descrie-bes the sectoral decomposition of posting missions performed in the second largest importer of posting services: France. I use the universe of mandatory posting declarations filed by foreign suppliers that send posted workers in the French territory (DPD/SIPSI dataset) from 2016 to 2020. Since 2019, it is mandatory for foreign suppliers to report the 5-digit NACE code of the mission performed by foreign employees in France's territory. The identifier number of the using firm reported in the posting declaration further allows to recover the 5-digit NACE code of using firms' activity. I use these two informations to show the relationship between using firms' activity and type of activity offshored through posted workers, aggregated at the 5-digit level.

missions, and not number of unique posted workers, as workers may be posted several times during the year. Therefore, one issued form for posting corresponds to one posting mission. Importantly, the E101/A1 social security form only concerns posting of workers within the EU, as it is directly linked to the

Yearly statistics on E101/A1 dataset are centralized by the European Commission that collects from competent authorities in each member state the number of posting social security forms issued each year since 2005.[2] Interestingly, the E101/A1 forms were issued way before that, but the collection of this data was not used for statistics and reports purposes, as posting remained limited in magnitude. The only historical data available on E101/A1 numbers before 2005 have been collected from the European Commission (EC) by the ECLRC for the period 1987-2000. This early E101/A1 dataset allows to observe the total number of posting forms issued each year, without additional information at the sending-origin level. Since 2005, national social security organizations are required to provide yearly numbers of issued A1/E101 by destination member state, sector of activity, and employment status. However, for earlier years (2005-2008),

[2]It is interesting to note that the EC started to constitute a detailed and exhaustive dataset on posting in 2005, one year after the biggest European enlargement that led posting to gain a substantial importance in the EU.

Table A.16: **Importer Premia of Firms Purchasing Posting Services**

Log Turnover	3.11***
	(.01)
Log Employment	1.64***
	(.01)
Log Capital/Worker	.50***
	(.01)
Log Payroll/Turnover	-.14***
	(.01)
Log EBT/Worker	.16***
	(.02)
Log Total Subcontracting	2.43***
	(.02)
Log Temp Agency Payroll	.81***
	(.03)
Log Average Domestic Wage	.19***
	(.003)
Share of Fixed Employment Contracts	.004***
	(.001)
Fixed effects	5-digit Sector

Notes: *p<0.10, **p<0.05, ***p<0.01. This table displays the estimates of import premia at firms that used on-site offshoring in France in 2018. As it is standard in the literature, the import premium is obtained by regressing the log of firm outcome variable on a dummy that is equal to one if that firm has used services provided by a foreign supplier "on-site" and a 5-digit sector fixed effect. The coefficient can thus be interpreted as the average difference between offshoring and non offshoring firms within an industry. Data on French using firms' come from confidential administrative tax records (ESANE/FARE) and do not include companies operating in the agricultural sector as they benefit from a different tax regime.

part of sending countries only reported total issued posting forms. From 2009 onwards, all countries report disaggregated number of posting forms at the bilateral level (origin-destination). The coverage of the data at the origin-destination-sector level has not always been exhaustive, as some member states chose to report the statistics at the sectoral-destination level only for most recent years. To avoid potential biases induced by this break in E101/A1 data collection, the 1987-2017 series are not exploited in the empirical analysis. I focus my empirical analysis on the 2009-2017 period when using the E1/A101 dataset on posting, and use other administrative datasets with no breaks in data collection when investigating the effects of posting with a longer time perspective.

The E101/A1 dataset has been used as the main source of information to track posting in the EU, especially by the European Commision that produces yearly statistical reports on issued social security forms for postings since 2007 (see for instance **?**).

Pluriactive workers While I focus on E101/A1 forms issued for posting within the EU (article 12), the E101/A1 forms are also issued for "pluriactive" workers (article 13): these workers have several employment in several member states, but stay affiliated to their home social security institution. In some cases, posted workers can hold a A1 social security security for pluriactivity (article 13) rather than posting (article 12), as discussed in **?**. To be conservative on the overall quantification of posted workers, I focus on posting forms issued for posting of workers only. If we include the social security forms for article 13, the amount of individuals exempted from destination-level labor taxes in country of work reaches 3 million of individuals.

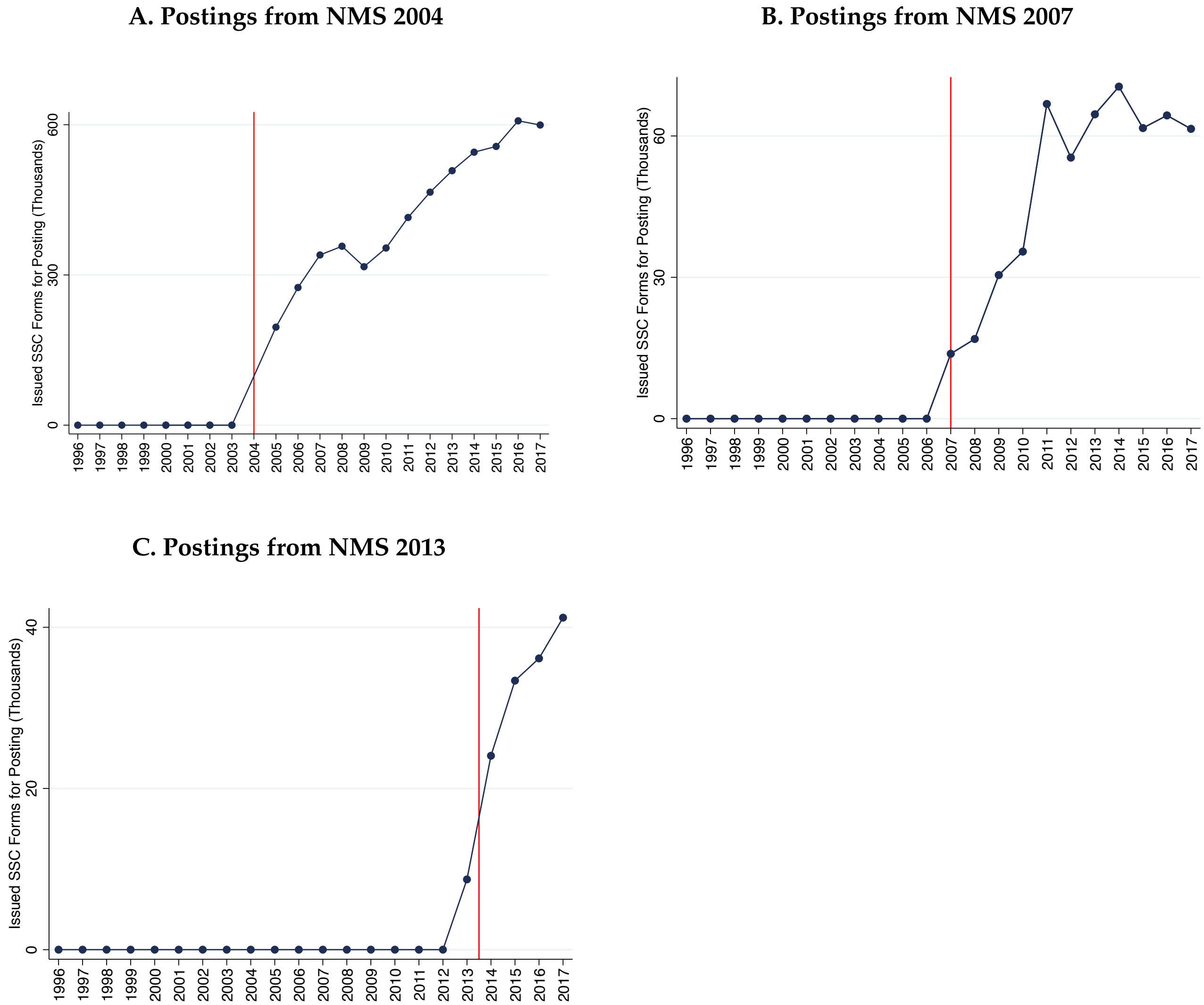
Table A.17: **Proximity between using firms 2-digit activity and purchased posting service**

Core Activity at Using Firm	Core Activity of Foreign Services Suppliers Same 5-digit Activity	 Same 2-digit Activity
All	22.7%	56.4%
Agriculture	46.4%	94.8%
Business Support	5.3%	10.0%
Construction	35.8%	80.5%
Electricity Supply	13.2%	19.3%
Extractive Industries	15.2%	36.2%
Finance Insurance	5.1%	20.4%
Health	1.5%	2.3%
Hotels Restaurants	39.0%	63.7%
ICT	13.4%	44.2%
Manufacturing	13.9%	55.0%
Real Estate	0.4%	0.4%
Repair/Retail	5.3%	9.1%
Scientific Technical	0.6%	1.2%
Transport	5.6%	35.7%
Water Supply	2.9%	25.9%

Notes: This table descrie-bes the sectoral decomposition of posting missions performed in the second largest importer of posting services: France. I use the universe of mandatory posting declarations filed by foreign suppliers that send posted workers in the French territory (DPD/SIPSI dataset) from 2016 to 2020. Since 2019, it is mandatory for foreign suppliers to report the 5-digit NACE code of the mission performed by foreign employees in France's territory. The identifier number of the using firm reported in the posting declaration further allows to recover the 5-digit NACE code of using firms' activity. I use these two informations to show the relationship between using firms' activity and type of activity offshored through posted workers, aggregated at the 2-digit level.

Therefore, the numbers used in the paper to measure the aggregate number of service contracts in Europe is biased downward, and can be interpreted as a lower bound for the overall magnitude of trade in services through posted workers in the European Union.

Figure A.58: **Effect of Posting Liberalization on Postings from Treated Countries**



Notes: This Figure shows the effects of services exports mobility libralization on international mobility through postings within the EU. As described in the text, EU accession triggers transition from quasi autarky to full liberalization of mobility of workers through firms' trade in services for new member states.

A.4 Data Appendix:CBHP Dataset

Data description and sample restriction I leverage administrative dataset on the universe of firms in the non-financial sectors established in Portugal. The dataset has been provided by the Bank of Portugal and comes from compulsory tax declarations (IES declaracao simplificada). The CBHP/CB dataset cover the population of all Portuguese non-financial corporations. The classification of non-financial corporations follows the guidelines on the "European System of National and Regional Accounts" (ESA 2010). It includes market producers mainly dedicated to the production of non-financial goods and/or services, such as private and public corporations, cooperatives and partnerships recognized as independent legal entities, non-profit institutions or associations serving non-financial corporations, public independent legal entities, private and public quasi-corporations, and head offices. The IES declaraiton is mandatory and contains tax, accounting and statistical information at the firm and establishment level, and is submitted electronically to the Portuguese Ministry of Finance every year. The Tax Authority sends the information collected through IES files to the Institute of Registration and Notary Affairs (IRN) that is then in charge of sending the files to Banco de Portugal that implements a quality control of the data.[3] Importantly, the information reported in the IES is cross-checked with other administrative sources, such as Quarterly Survey of Non-financial Corporations (ITENF), the Central Credit Responsibility Database (CRC), the Communication of External Transactions and Positions (COPE) and the Securities Statistics Integrated System (SIET). The dataset contains exhaustive information on firms' balance sheets, including detailed information on firms' financial activity, employment, investment and taxes paid. In addition of these financial and employment information, firms are required to provide information on their activity performed abroad. More specifically, firms report every year the amount of earnings derived from prestation of services performed in the EU market. I use this exhaustive information on firms' prestation of services outside Portugal to select posting firms established in Portugal.

When firms post workers abroad in order to perform a service, the transaction is recorded as an export of services from the country where the firm is established to the country where the work mission is performed. To robustly identify posting firms in the CB/CBHP dataset, I focus my analysis on sectors where international provision of services can only be performed through the physical presence of persons abroad. I follow the methodology used by central banks to identify service exports through the temporary sending of workers abroad (mode 4 in GATS for the balance of payment computation). The method consists in selecting the branchs of activity where services can only be physical, and thus have to be performed locally by workers. For instance, sectors like construction, installation of machinery, plumbing, transport by road, are sectors where exporting a servicerequires to send workers to the site of the customer. Following this so-called "balance of payment" methodology, I use the very fine classification of sectors (5 digits) provided in the CBHP dataset in order to select sectors where services can only be exported through the posting of workers. The exercise leads to a final selection of 27 sectors where cross-border provision of services relies on employees' geographical mobility across space. This methodology induces a lower bound on the selection of posting firms, as posting may occur in other sectors, like manufacturing or other services, where services exports through presence of workers abroad cannot clearly be separately identified from services exports where the service itself crosses the border. However, data from Luxembourg Overall, my analysis can be more generally interpreted as studying the effects for firms to perform services abroad, which is exactly what is made possible by the posting policy within the EU.

My sample is constitute by the population of operating firms in Portugal that are active at some point between 2006 and 2017 in the 27 sectors where the performance of services abroad can be automatically assimilated to the sending of workers abroad. I restrict my attention to firms with a median of at least

[3] More information on CB and CBHP datasets are available at .

Table A.18: **Coverage of the Estimation Sample**

Number of Workers	93%
Hours Worked	94%
Wage Bill	96%
Total Assets	72%
Turnover	85%
EU Service Prestations	93%

Notes: This Table shows the coverage of the estimation sample after the minimum size restriction that drops firms with a median of less than 3 workers across all years of activity.

3 workers across all years of activity in order to avoid measurement noise induced by very small firms, following **?**. The selected final estimation sample covers almost exhaustively the full economy, as showed in table A.18. I also drop a minor number of firms that performed services in a country outside the EU, as these services provisions are not covered by the European posting regulation, but by the restricted posting policy for non-EU member states.

Figure A.59: **Identifying Services Exports Mobility in Trade Data**

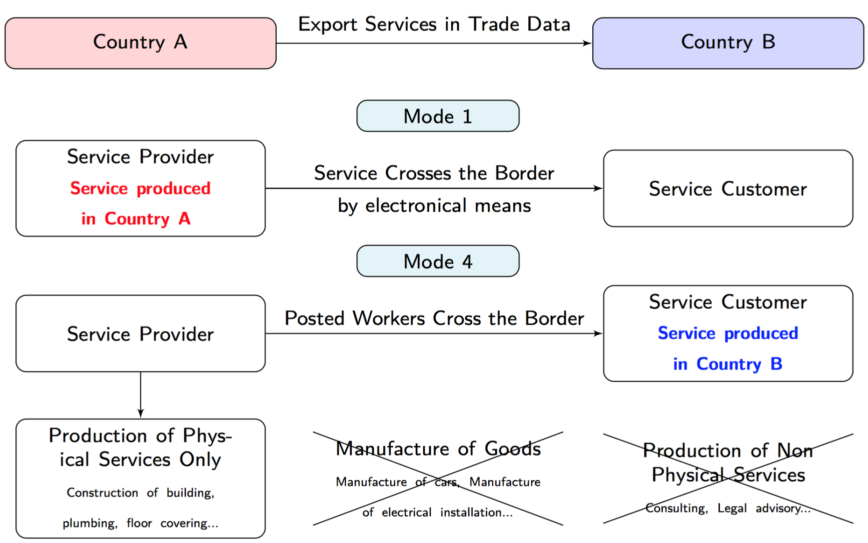


Table A.19: **Descriptive Statistics on Never and First-time Poster**

	Mean	SD	Median
Never Poster in 2009			
Number of Workers	10.2	23.7	6
Hours Worked	18,972	42,505	11,063
Wage Bill	136,507	487,590	64,461
Total Assets	1,183,463	7,646,896	221,670
Turnover	625,085	3,650,053	192,388
EU Service Prestations	0	0	0
First Time Poster in 2009			
Number of Workers	15.9	87.2	7
Hours Worked	28,275	122,200	12,320
Wage Bill	199,854	722,610	74,670
Total Assets	726,288	3,488,864	234,949
Turnover	776,124	4,063,276	252,071
EU Service Prestations	0	0	0

Notes: Statistics for each variable are calculated only across the firms with non-missing values for that variable that year. All values correspond to 2009, a year that is by construction prior to all events. The upper panel presents raw summary statistics for the sample of firms active in 2009 and never observed as posting workers in the 2006 to 2017 balance-sheets data. The middle panel presents raw summary statistics for the sample of firms active in 2009 and observed as posting workers abroad for the first time sometime between 2010 and 2015. Firms observed as performing services abroad for the first time after 2016 are dropped altogether from this calculation.

Table A.20: **Description of Posting Events**

Year/Event Year	0	+1	+2	+3	+4	+5	+6	+7
2010	632	327	285	236	205	167	157	136
2011	688	378	307	239	208	174	153	
2012	748	465	355	298	250	204		
2013	733	456	338	290	237			
2014	685	402	321	246				
2015	665	395	299					
Total	4,151	2,423	1,905	1,309	900	545	310	136

Notes: This Table refers to all firms established in Portugal and observed as posting workers for the first time sometime between 2010 and 2015. The second columns describes the distribution of the first posting events by calendar year. In event year 0, by definition, all firms that start posting workers have to appear in the calendar year of their event-year. In the column of event year +1, I report how many of the firms who experience the event in a given calendar year are still posting workers one year after their event. The last column describes the number of firms that still post worker abroad seven years after their first posting of workers. By construction, some cells are empty. For instance, I cannot observe firms that are first posting workers in 2015 (hence have event year 0 as 2015) in event year +3, as the balance sheet data only covers 2006-2017.

A.5 Data Appendix: DPD/SIPSI Database

In this Appendix, I describe in details the dataset for posting to France. The dataset comes from compulsory posting declarations (*"déclarations préalables de détachement"*-DPD) that are sent from foreign companies to the French administration for the period 2000-2020. France has implemented a special registration tool covering the universe of workers posted to the French territory. Before any posting of workers to France, the foreign employer is required to send a pre-posting DPD to the departmental directorate of labor (*"direction départementale du travail"*) of the place where the work mission will be performed. The DPD contains information on the identity of the company established abroad (sending firm) and of the firm established in France (receiving firm), the number of workers posted to France and the demographics of these workers (full name, age, permanent address in origin country, citizenship), information on the work mission performed (duration, sector of activity, address of the work mission) and wages paid to posted workers. The DPD is compulsory for any posted workers sent to the French territory. If this document is missing, the employer in the origin country and the company receiving the workers in France are liable to sanctions, and fines. Any missing DPD document also implies that the work mission is interrupted. French law also requires that foreign companies posting one or more employee to France have to appoint a French legal representative (Article L1262-2-1 of the Labor Code).[4]

The French ministry of labor, and more specifically the DGT (*"direction générale du travail"*) centralizes the information on the number of DPD papersheet forms received by each locality since 2000.[5] From 2000 to 2015, the central administration (DGT) asked every year the local labor authorities based in each regions (DIRECCTE) to report the number of received DPD forms by province, sector, origin of sending companies and citizenship of posted workers. The received data were then centralized in a unified database: the DPD database. In the so-called DPD database, there is information on postings to France by sector of work, provinces and origin country for 2000-2004 that were initially reported by the DILTI, a French organism in charge of tracking illegal work in the French territory. From the 2000-2004 period, information on collected DPD declarations are available in historical reports wrote by the DILTI. In this report, I can find aggregated statistics on the yearly number of postings in France, and the decomposition of received posting flows in 2003 by French regions (the information at the province-level is not publicly available). This however allows me to get a picture of the spatial allocation of posting flows in the early stage of the posting scheme. Since 2005, the information on received posting flows is available for each French province (*département*), by sector of work and country of origin of the posted workers. In the sector-province-origin level dataset on posting inflows, the list of sector for posting missions is rather aggregated: construction, manufacturing, temporary employment, restaurants/hotels, agriculture and entertainment.[6] These sectors can be directly mapped to the A28 sectors in French local-sectoral administrative data on employment; with the corresponding sectoral

[4]This legal representative is the liaison between the foreign company and the French authorities.The appointment of this representative is made in writing and must be signed by both parties (the company and the legal representative). This designation has to be translated into French so that it can be valid.

[5]No data on DPD have been collected before 2000, because the number of DPD was so marginal that no collection on the information was put in place according to the local labor market responsibles.

[6]There is also an "other" category that we cannot allocate to any sector for French employment, but this category represents a moderate share of all posting missions (less than 5% in most years).

codes being TFZ, TBE, TGUMNZ, TGUIZ and TAZ. The data on French employment at the province-sectoral level is produced by the INSEE since 1989, is based on micro administrative data, and measures salaried employment by NACE 28 at the year of the year.[7] I select these sectors as the exposed sectors, while all other sectors where no posting missions can be observed (TGUO), are defined as sheltered. I exclude the public sector ("tertiaire non marchand", TOQ) from the analysis, as this sector is less likely to adjust to local shocks, and may bias the estimates of overall reallocation. I use data on province-level working-age population (20-59 years old individuals) from publicly available statistics produced by the INSEE.

Since mid-2016, the DPD has to be filed electronically through the SIPSI online application. The SIPSI database corresponds to the disaggregated version of the DPD dataset for the period 2016-2019. The SIPSI database contains three datasets that can be linked. The first dataset within SIPSI covers all declarations (or notification) made by foreign services suppliers, and includes information on the supplier ID, the receiving firm or client ID, the sector of the task performed, the sector of the receiving firm, the duration of the service mission, the geographical location of the sending and receiving firms, whether the sending firm directly paid for housing, food and travel costs that relate to the posting mission. The second dataset ("employees dataset") relates to the posted workers linked to each declaration. In the employees dataset, there is extensive information on posted workers' demographics (age, address, citizenship, gender), wage during the posting mission, and work contract (occupation, date of starting contract with the sending firm). The last dataset relates to posting mission location ("prestation dataset") and provides information on the geographical location where the posting mission is performed (e.g., where workers can be controlled by labor authorities). The posting mission can sometimes be associated to long subcontracting chains. If a French construction firm use posted workers sent from a Polish temporary employment agency to work for a third french firm, the ID of this third firm will be associated to the location where the work mission is effectively performed.

Matching algorithm between posting registry and linked employer-employee datasets I merge the SIPSI database on all posting missions to France between 2017 and 2020 with administrative data on French workers and firms for the same period. More specifically, I use the SIPSI file on "posting missions" (fichier salariés) that contains one line per posting contract, merged with the "declaration" file that contains one line per declaration made by the foreign firm, and has information on sending and receiving firm ID. I end up with a dataset where one observation identifies a posting mission with joint information on sending firm, receiving firm, and worker identifiers.

To obtain information on domestic workers, I use matched employer-employee data based on payroll declarations filed by French companies for their domestic workers (DADS). I use the exhaustive version of DADS (*DADS postes*) that covers all employment spells in France for a given year. The DADS contains exhaustive information on wages, hours of work, occupation and other demographics, and importantly allows to observe employers' and employee's unique identifiers (SIREN). Since 2018, the DADS also allows to link temporary employment agency workers to the identifier of the firm where they perform their work

[7]The data are publicly available https://www.insee.fr/fr/statistiques/4981499?sommaire=4981513.

mission, in addition of their formal employer (the temporary employment agency). The DADS contains exhaustive information for all job spells in France for two consecutive years.[8] I use DADS Postes 2018 to track job spells of French workers in 2017 and 2018: I can observe workers' moves across employers in a given year (if employees have several jobs, or change jobs during the year), as well as between the two years.

I use the common firm identifier (SIREN) to link the posting registry with the DADS database. The SIPSI dataset identifies receiving firm with a triplet of information: the SIREN, the VAT number, and the name of the company. These information are filed by the foreign supplier, and can either be partially filed (only one of three information available), or can contain mistakes. To maximize the number of observations with a SIREN number, I develop a matching algorithm. I use the tax registry FICUS/FARE to select SIREN numbers and names of all companies registered in France in 2017 and 2018. I then match the SIPSI database with the FICUS/FARE registry on SIREN number first, then on several combination of the VAT number, and finally on names. For firms matched through names or combination of VAT numbers, I can then use the SIREN number present in the FICUS/FARE dataset.

After implementing this matching methodology, I am able to observe unique firm ID for respectively 78% and 74% of posting missions starting respectively in 2017 and 2018. A missing SIREN number in the SIPSI declaration can be explained by several factors: if the client is an final customer rather than a firm, if the firm that subcontracts the mission is established outside France or ultimately if the declaration has not been fully filed. With this final dataset at hand, I can finally merge the SIPSI database with the DADS database through the SIREN number. Few receiving companies in the posting registry are left unmatched: these are companies that are registered but do not have paid employees. In the end, the matched DADS-SIPSI dataset still captures 75% of posting contracts and posting wage bill. I further winsorize posted workers hourly wage at the 1% level to get rid of extreme values that may be driven by declaration mistakes made by foreign services suppliers.

[8]There exist a longitudinal version of the DADS that allows to track individuals for a longer period, but is based on a sample of 1/12 of the French population.

A.6 Data Appendix: IGSS Dataset

The IGSS dataset is an administrative matched employer-employee dataset that covers all corporations operating in Luxembourg since 2002. The dataset combines all monthly payroll declarations for employees, civil servants and self-employed filed in Luxembourg and all individual social security registries. The dataset therefore allows to obtain information on invidividuals and employers, and allows to track individuals across employers over time. It contains detailed information on workers' individual characteristics, such as age, gender, citizenship, residence and date of arrival in Luxembourg. A job in the dataset is identified through a unique identifier, and combines a unique worker, a unique employer, and a unique date of beginning and of end. The dataset allows to observe each month the universe of active jobs, with information on hourly wage, hours of work, type of contract and sector of work activity. The matched employer-employee dataset is merged at the worker-level with information on posting missions declared by companies to the Luxembourgish social security institution. I am thus able to observe the universe of posting firms located in Luxembourg, and to observe which worker is sent abroad within the firm exporting non-tradable services abroad.

The IGSS dataset is available at the monthly level for 2002-2020. More specifically, the dataset has one observation per active job each month. To obtain a dataset at the firm-year level, this is how I procede. I first build a dataset at the month-employer-employee level: if an individual has several jobs at the same employer for a given month, I build a unique observation that takes the total of hours worked by this employee at that employer, the average monthly hourly wage, as well as the total number of posting missions performed by that employee. I then collapse the dataset at the firm-month level: for each firm each month, I compute the total number of hours worked by employees, the total number of employees working at the firm this month, the total number of employees of that firm posted abroad that month, and the average hourly wage of employees working at that firm that month. To go from the firm-month dataset to a yearly firm-level dataset, I then take for each firm the average of these variables across the 12 months of the year. The final dataset has one observation per firm and year from 2002 to 2020 and contains information on firm ID, average hourly wage at that firm, the total number of employees at that firm, the total number of posting services performed abroad by employees of that firm, and the total number of hours worked by employees of that firm.

A.7 Data Appendix: LIMOSA Dataset

The LIMOSA dataset is a posting registry that records all posting declarations filed by foreign companies in order to post workers to Belgium. The specific posting declaration has been implemented in 2008, has to be made before any posting of workers to Belgium (including self employed who post themselves abroad) and is mandatory. Some workers hired abroad who come to work temporarily to Belgium are exempted from a LIMOSA declaration: workers operating in the transport sector, workers coming to Belgium for a scientific event (congress, conference etc), scientists and researchers who participate to a research program, top executives who come to Belgium to participate to an event (for instance foreign executives who come to assist to a board meeting), workers who come to install goods, athletes who come to Belgium to participate to an international competition, international civil servants, workers from international organizations, and business men.

The LIMOSA dataset allows to observe the total number of posting declarations that have been filed by companies, whether they have been cancelled or not later on. Because interpreting cancelled posting declarations would require additional information and assumptions, I focus on declarations that are not cancelled by firms. The data contains an information on start and end of the posting mission, an unique ID for the posted worker, the sending company and the Belgian client. It also provides detailed characteristics on the posted worker (age, citizenship, residence country, self employed status) and the posting mission (postal code of the work mission, duration, sector of work activity). In the LIMOSA database, a posting mission is defined as the unique combination between a start and end date of the posting mission, a Belgian client, a foreign employer, an individual ID, and a declared workplace in Belgium. In cases where the posted workers are hired by a given Belgian client, but are working for a second client in Belgium, the dataset also provides the ID number of this indirect client. For instance, if a catering company established in Belgium sucontracts waiters posted from a firm established in Poland, and then use these workers to perform a service at a Belgian restaurant, the LIMOSA dataset will provide the ID numbers of the direct and indirect client. The unique ID number of the Belgian client can be associated with the Belgian fiscal number (KBO number). For posting declarations with an information on the KBO number, I can link the posting declaration to information on domestic workers of the receiving firm.

A.8 Labor Posting Responses Through Mobility Duration

This section shows that posting responses to fiscal incentives not only occur through changes in the number of individuals who are posted each year, but also through mobility durations of international mobility periods.

For this purpose, I investigate the distribution of posting durations around a regulatory threshold that determines the income tax residency for individuals posted abroad. This internatioanl fiscal rule, known as the 183 days rule, establishes the income tax regime that applies to the income earned abroad by posted workers, and in some cases of the total income tax regime of workers posted abroad. International tax treaties establish that individuals pay income taxes in the country where the work activity is performed. However, if the employer is not located in the country where the work mission is performed by its employee, and if the employee works less than 183 days in the country of work, the income tax can exceptionnally be levied by the country of residence, and not the country of work. For instance, the general rule will thus states that a French resident who is posted for 3 months to Belgium will not be liable to the Belgian income tax on the income he will receive for the posting mission. On the other hand, if the employee works for more than 183 days in one country, the income tax on the wage received for the work mission is levied by the country of work, and not the country of residence. Beyond determining the income tax regime of part of individuals' income that is linked to the international mobility mission, the 183 days rule can also in some cases determine the overall tax residence of individuals. For taxpayers who do not keep a "central financial interest" in their origin country, staying more than 183 days in the country of work may shift their total fiscal residence abroad.

The 183 days rule thus creates some room for mobility duration manipulation that could shift individuals' tax residency, either only for the part of the wage linked to the posting abroad, either for the totality of individuals' income and wealth. The incentives to fall just below or above the duration threshold depend on individuals' income level, differences in country of work and country of origin income tax schedules, and other idiosyncratic determinants of their income tax bill. To investigate whether individuals react to these incentives, I investigate the distribution of posting missions duration in Belgium around the tax residency discontinuity created by the 183 days rule. The Figure shows a distinctive pattern around the 183 days tax residency threshold. First, there is an excessive mass of posting missions with durations around the threshold compared to the mass of posting mission durations elsewhere in the distribution. If part of this excess mass can be explained by bunching at reference points, because of the 6 months duration, the comparison with the excess mass observed at the 5 months reference point suggests that this mechanism cannot explain alone the magnitude of the observed excess mass around the 183 days threshold. Second, the shape of the distribution around the 183 days threshold takes a distinctive pattern, that is never observable elsewhere in the duration distribution. The distribution of posting missions duration is *double-picked*, with a clear double bunching of posting durations just below and just above the threshold, while the number of people who locate at exactly 183 days is lower. This distinctive pattern of mobility duration around the tax residency threshold suggests that some individuals tend to bunch below 183 days, in order to keep their wage under the country of origin income tax schedule, while other tend bunch just above the 183 days threshold in order to shift their income tax to the country of work schedule. To better understand how postings' duration react to the tax residency threshold, more information on individuals' currnt and counterfactual tax liabilities is needed, and will be used when additional data will be obtained. Nevertheless, the double picked shape of the duration distribution emphasizes the existence of bunching both just below and just above the threshold, and confirms the existence of posting duration manipulation induced by the 183 days discontinuity in income tax residency rule.

A.9 Are Posted Workers Different From Standard Migrants?

A natural question following the trade-related boom in mobility generated by posting is whether the increase in international mobility though posting may occur at the expense of other international mobility channels, such as permanent migration. In that case, the overall aggregate mobility effects of posting policies may be lowered by crowding-out of permanent migration. In the main paper, I investigate potential substitution and crowding-out between posting and migration flows and provide evidence that posting is not used as a substitute for permanent migration.

In this subsection, I discuss and test potential mechanisms that suggest that firms alleviate part of the frictions that constraint individuals' migration decision.

Permanent migration of individuals may first be constrained by information frictions. Individuals can lack experience in knowing how to search work opportunities abroad, because it requires specific knowledge about the foreign country. For instance, a given worker who wish to move to France or Italy may be able to search for jobs in these countries, but will most likely not be able to search simultaneously in every possible destination countries. Firms could have a specific information technology that allows them to be efficient in searching the best opportunities for their workers to provide services abroad. Because of this advantage in information technology, some services suppliers may even get further specialized in the provision of services abroad, and in "efficiently matching" demand and supply of services across states.

Migration is also subject to important fixed costs that are borne by individuals. For instance, migrating abroad may require to learn a new language, to comply with administrative and search costs (send a CV, establish a new employment contract abroad, find a place to live in the new country etc). Service suppliers can centralize these fixed costs and may therefore experience increasing returns in the international mobility of workers, in contrast with permanent migration based on individuals' decision alone.

Finally, individuals can face financial constraints that restrict their international migration decisions. Moving and working abroad requires important initial expenses, in order to travel, to settle and start a professional activity in another country. While individuals may not have the financial means to do so, foreign services suppliers finance these costs, by paying for all workers' expenditures abroad.

A first path to investigate whether posting firms alleviate part of mobility frictions faced by individuals is to study which workers self-select into mobility intermediated by firms, in contrast with standard migration. Differences between workers who move through firms and individuals who decide to immigrate could be suggestive of underlying frictions and determinants of posting compared to standard permanent migration. For a given destination country, I compare the characteristics of workers posted by firms to this country (posted) versus the characteristics of foreigners who moved permanently to this country (migrants). I focus on Belgium and France as destination countries as these countries provide detailed data on posted workers' demographics. The Figure shows striking evidence that individuals moving through posting exhibit systematic and significant differences compared to migrants.

Migrants are on average 24 years old when they move permanently to their new country of residence, while workers are on average 38 years old when they are posted abroad by their employer. As age is heavily correlated with potential attachment to the origin labor market, this first difference is suggestive that labor posting is used by workers that potentially face larger mobility costs compared to standard migrants.

A second key difference between posted workers and migrants regards the country of origin. While 50% workers who move through firms originate from lowwage European countries (NMS13), its is only the case for 5% of overall permanent migrants. This difference suggest that large distances and cultural differences between destination and origin countries constraint permanent migration from Eastern European countries to the West, while it does not affect posting flows. This fact can also be verified at the Europe-wide level. The international mobility effects of free migration agreements for NMS have been very heterogeneously shared across destination countries. While Ireland and the UK captured 60% of permanent emigration from Poland, most of other countries saw limited migration inflows. In contrast, the aggregate mobility gains triggered by posting liberalization were much more homogenous across EU countries. For instance, the number of workers posted from NMS 2004 to France increased by 450% after that posting flows were liberalized, while the effect of permanent migration liberalization for NMS 2004 to France did not have an effect statistically different from zero on permanent migration flows from these countries. What explains that the aggregate mobility gains of permanent migration liberalization waves since 2004 have been mostly directed towards some destination countries? One of the main rationale that has been put forward by the European Commission is that english-speaking countries were much more accessible for migrants, compared to other countries. In contrast, as posting does not require to learn the language or to integrate the domestic labor market, most of labor mobility coming from the East in countries like France, Netherlands, Belgium or Austria has occured through posting rather than immigration. This explanation suggests that mobility frictions and costs such as language or labor market rigidities have restricted permanent migration flows to some countries, while not constraining posting flows to these countries.

A final central aspect of posting flows relates to the average level of education of workers posted abroad by firms. It has been showed that migrants tend to be positively selected in terms of education levels and face lower mobility costs and frictions than high skilled. I show that the traditional "mobility gap" documented by the literature for standard permanent migration is reversed when the mobility is intermediated by firms. While tertiary educated workers represent 30% of migrants, they only account for 2% of workers posted abroad by service suppliers.[9] Workers with lower levels of education may face higher migration frictions in terms of language, liquidity constraints or ability to access relevant information regarding work opportunities abroad. Firms may be able to substantially alleviate mobility frictions faced by these individuals, by setting-up the mobility transaction and by providing all mobility costs required by the mission abroad, such as transportation and housing.

A second way to understand what is the key role played by firms in mobility costs and frictions is to focus on self-employed posted workers. Self employed posted workers are individuals who decide individually to provide a service mission abroad: they thus face similar information, search and mobility fixed costs and frictions than permanent migrants. In the case of employees posted abroad by their employer, these costs and frictions are entirely borne by the sending company. Self-employed who post themselves abroad therefore provide a unique laboratory to study the role of individual-level mobility frictions in poting. If posting firms do not play a key role in alleviating these frictions, one may expect posting flows to be largely composed by individuals who post themselves abroad. The data shows that in 2016, self-employed individuals represented only 8% of the overall number of postings within the EU. Therefore, most of posting flows are indeed explained by employees sent abroad by a service supplier, rather than individuals who would individually use posting in order to work abroad, which provides evidence that firms play the central role in posting flows. To understand whether the large aggregate mobility gains from posting liberalization

[9] Interestingly this large difference holds even after adjusting for different composition in origin countries. I find that 27% of migrants from NMS 13 countries have a tertiary level of education against 2% of posted workers.

is explained by firms or individuals responses, I further study responses of employees and self-employed flows to the same mobility cost shock in Figure A.60. The Figure shows evidence that international mobility responses to a posting liberalization reform are fully driven by employees posted abroad by their employer, rather than self employed. This therefore indicates that firms do alleviate part of the mobility frictions that are borne by individuals both in migration or self-posting decisions. The role of firms in alleviating information frictions faced by individuals can also be emphasized from the granular data on posting. Using individual-level data on workers posted to Belgium, I find that almost 30% of self-employed posted workers came earlier as employees posted by their employer. This confirms that service suppliers play a key role in acquiring important information about the destination country that may be later passed on their workers.

Figure A.60: **Employed Versus Self-Employed Mobility Response to Posting Liberalization**

Notes: The Figure depicts the log of posted workers flows between two countries against the labor cost differential between these two countries. A positive slope means that a higher labor cost in the destination country compared to the origin country leads to higher posted worker flows from the origin to the destination country.

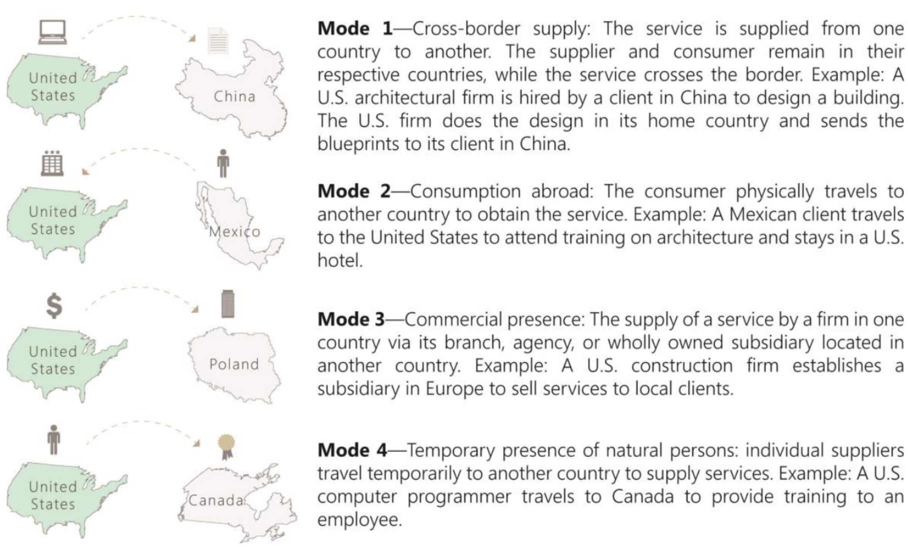
A.10 Posting Policies Across the World: Where do We Stand

A.10.1 WTO Regulatory Framework

According to the official definition given by the WTO, international trade of services embeds four types of services supply. The modes of supply are defined based on the location of the service supplier and the consumer. A service can first be supplied from one country to another. In that case, both the service supplier and consumer stay in their country while the service crosses the border (mode 1). The consumer can also travel to consume the service abroad, typically for tourism purposes (mode 2). A foreign service provider could set up a branch, agency or subsidiary in another country in order to perform its activity there (mode 3). Finally, a service supplier can perform a service in the country where the consumer is established by sending its workers temporary abroad (mode 4). These 4 modes are described in Figure A.61. Services offshoring, which can be defined as the production of services tasks by foreign instead of domestic workers, thus only occurs with mode 1 and mode 4 of services provision.

Services offshoring is usally studied through the lens of mode 1 provision only, where the service mission is produced in the territory of a foreign country and is then imported and consumed by domestic entities.

Figure A.61: **Mode of Supply for International Trade in Services**



Source: Congressional Research Service "U.S. Trade in Services: Trends and Policy Issues" (2020).

A.10.2 An Overview of Posting Policies in the World

Because it generates a unique interplay between destination-level territory and the production of the imported service, cross-border provision of services is amongst the most regulated type of trade flows and is most of the time restricted by important barriers. Countries can in particular impose heavy restrictions on the movement of foreign firms' workers through compulsory temporary business visas and work permit restrictions. Today, few countries have fully lifted entry barriers for foreign employees sent abroad to perform services. The EU has by fat adopted the most liberal mobility regime for the cross border provision of services in the world.

The North American Free Trade Agreement (NAFTA) signed in 1994 between Canada, Mexico, and the United States, and that has been replaced by the novel USMCA in 2020, regulates the international mobility of workers for temporary cross-border service provision. The agreement establishes the procedures for the temporary entry of individuals that are involved in international provision of services in the territory of another member state (business visitors and professionals). For a restricted set of workers and sectors involved in services related movements, the NAFTA/UCSMA provisions eliminate some of labor certifications, work permits and right of residence restrictions. Foreign workers whose occupations is included in the list of 63 narrowly defined occupations are allowed to temporary entry in one of these three countries in order to perform a temporary work mission. Workers sent from a company established in one of the NAFTA members and that satisfy the agreements criteria are for instance exempted from the labor market opinion process, and have access to a specific temporary entry visas. Despite these specific dispositions, the regulation of services exports mobility in North America stays very restrictive compared to the European approach. First, the exemptions are only granted to a very specific set of occupations, are not open to self employed, and only benefit to highly qualified individuals who aim to pursue a temporary work mission in sectors like research, medical activities, or engineering.[10] Second, if these foreign workers may benefit from a more flexible way to access the domestic market compared to other foreigners, they still have to request a work visa authorization. The country of destination keeps the right to unilaterally deny the temporary entry, and therefore entirely keeps the control of services related flows in its territory. Finally, foreign workers who aim to perform a temporary service mission still have to provide a large number of documents, such as qualification degrees.

In Africa and South America, policies that are very close to the European posting policy have been implemented, most of the time in recent years. For instance, since 2010 and the entry into force of a novel social security agreement between Chile and Argentina, firms established in one of these countries can send their workers freely to the other country for a maximum duration of 24 months. A worker hired by an employer established in one of country who temporarily provides services in the other country is subject to the employment law of the origin country, not the destination country. The treaty also establishes that workers sent abroad by their employer are fully exempted from labor taxes and social security contributions in the country of work. The recent Argentina-Chile (de)regulation of mobility-dependent trade is therefore almost identical to the initial provision for posting adopted in the EU in 1959. Interestingly, the disposition related to social security exemptions led to some political tensions regarding the adoption of the treaty, that took more than 7 years before being ratified by Argentina. In particular, some members of the Argentinian Congress were worried that the exemptions for foreign suppliers' employees could lead to unequal competition between workers hired in Chilean versus Argentinian firms, which echoes the European political debate on the exact same topic.

Trade liberalization of servoces has also been at work in the African continent. Within the APEC and the ECOWAS regions, firms are also allowed to send workers without restrictions for a maximum duration of 6 months, and these workers are fully regulated by the country of origin laws and social security contributions, similarly to what was in place in Europe before 1996.

Finally, many recent multilateral and bilateral agreements aim to enhance the international mobility of

[10]The list of occupations eligible to services exports mobility measures within the NAFTA is available at https://www.nafsa.org/_/file/_/amresource/8cfr2146.htm

services suppliers. For instance, the General Agreement on Trade in Services (GATS) provides the first and only multilateral framework of principles and rules that affect trade in services among 164 WTO countries. These countries have already committed to further liberalize the international mobility of workers sent by foreign suppliers to their territory. Mobility-dependent trade is thus likely to be a key issue for governments and labor markets outside Europe for two main reasons. First, as the current level of regulation of this international mobility channel is still high, there exists a large scope to enhance this novel integration channel. Second, countries' recent commitments to liberalize these flows indicate that future trade and migration policies will shift towards more flexible regime of mobility-dependent trade.

Within-country services provision through mobile employees Regulating provision of services through mobile employees can also be a key issue within countries, especially when taxes, social insurance and wages differ across states. For instance in the U.S, the Constitution does not contain an express statement setting forth the freedom to provide interstate professional services. Regulatory barriers such as occupational licencing apply to services suppliers that wish to send their workers to another state in order to perform a work mission. Remarkably, the posting policy therefore allows a somehow more flexible regulatory framework to cross-country mobility of workers through services provision than the national-level U.S framework. The U.S law also provides some labor market regulations of cross-state provision of services through mobile employees. The prevailing wages laws (PWL) implemented by the Davis-Bacon Act in 1931 mandates that construction workers, employed on federally funded or federally assisted contracts in excess of $2,000, should be paid no less than the *local* prevailing rate for similar work in the area. Because large public projects in an area may attract contractors from other regions, a potential problem arises when builders from low-wage areas bid on these projects. The U.S PWL ensures that this cannot be the case in public construction projects, by enforcing the minimum rate of pay based on the state of work, and not of employment of mobile workers. The Davis-Bacon Act is thus similar than the prevailing wage policy for posted workers applied in Europe. An interesting historical anecdote is that the European Posted Workers Directive of 1996, that introduced the destination-level requirements for posted workers, was directly inspired from the U.S Davis-Bacon Act for services provision across U.S states.

A.11 International Trade in Services in Europe

One main challenge is to bridge the gap between statistics on workers posted abroad to supply services (measured with social security forms) and the monetary value of services supplied by the posting of workers abroad. In the absence of linked social security and trade data at the EU-level, estimating the value of cross-border service contracts is challenging. This Table summarizes the value of trade-in-services flows in Europe by mode of supply, applying the balance of payment methodology.

Table A.21: **Within-EU Trade in Services by Sector and Mode of Supply, 2017**

Type of services	Mode 4 of supply (posting)	Billion euros
Manufacturing services on physical inputs owed by others	1	33,934
Maintenance and repair services n.i.e.	1	17,029
Sea transport	0	200,554
Air Transport	0.33	57,474
Other	0.33	96,641
Postal and courier service	0	5,566
Travel Services	0	252,429
Construction	1	19,1937
Insurance and Pension services	0	27,523
Financial Services	0	120,837
Charges of the use of intellectual property	0	61,058
Telecommunication and information	0	31,192
Computer and Technical Services	0.25	96,650
Development and professional services	0.25	141,460
Others (Agriculture, employment agencies, trade-related)	0.5	146,235
Personal and recreational	0.25	16,257
Government services	0.25	8,087
Total	276,802	1178912

Notes: This table gives an estimation of cross-border service trade in Europe through posting of workers. The data on within-EU trade in services are from Eurostat (bop_its6_det) in 2017, and provided by bop items. The share of flows associated with mode 4 service supply (posting of workers) is adapted from the MSITS 2010 methodology and the distributional of supply modes provided by Eurostat.

Appendix B

Tax Competition and the Geography of Trade in People

B.1 Additional Tables and Figures

Figure B.1: **Cross-Country Correlations Between Posting Bilateral Flows and Cost Differentials**

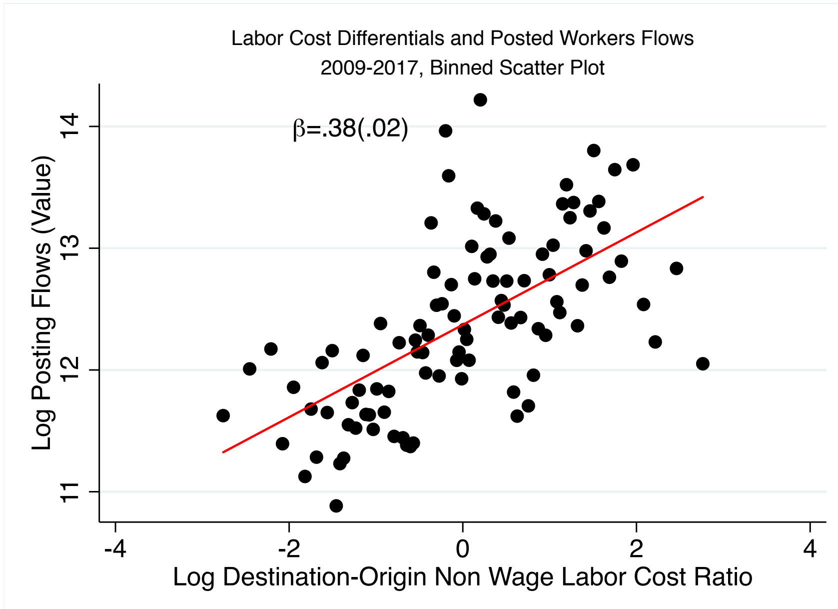
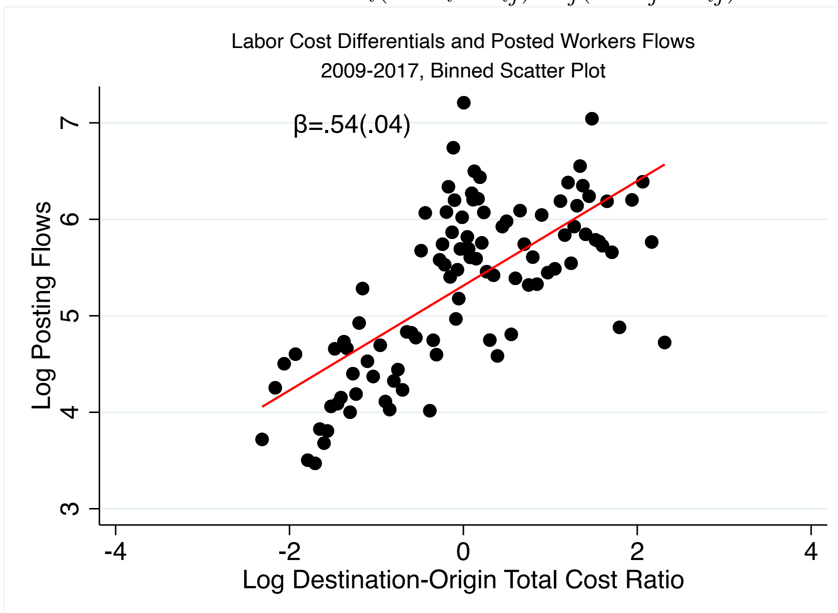


Figure B.2: **Cross-Country Correlations Between Posting Bilateral Flows and Cost Differentials**

A. Total Cost Ratio $w_i(1 + \tau_i + a_{ij})/w_j(1 + \tau_j + a_{ij})$



B. 1+ Payroll Tax Ratio: $(1 + \tau_i)/(1 + \tau_j)$

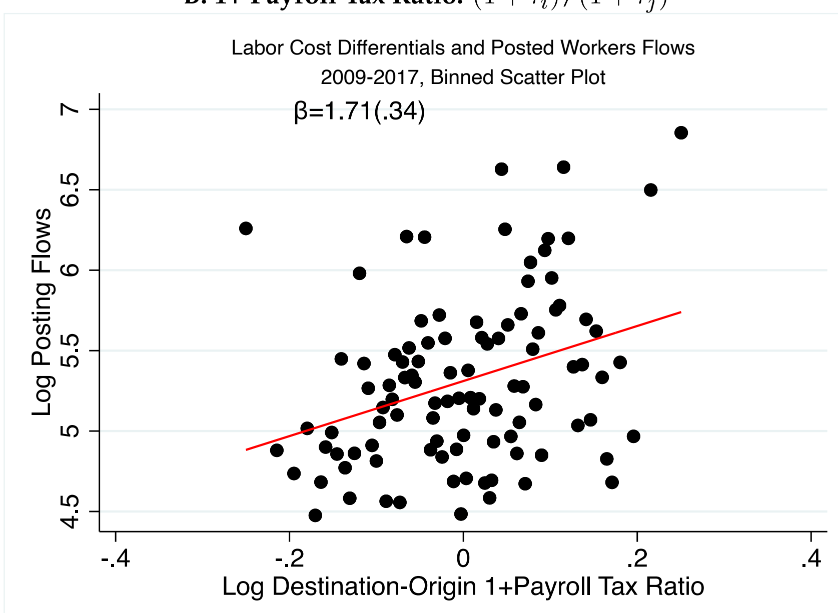
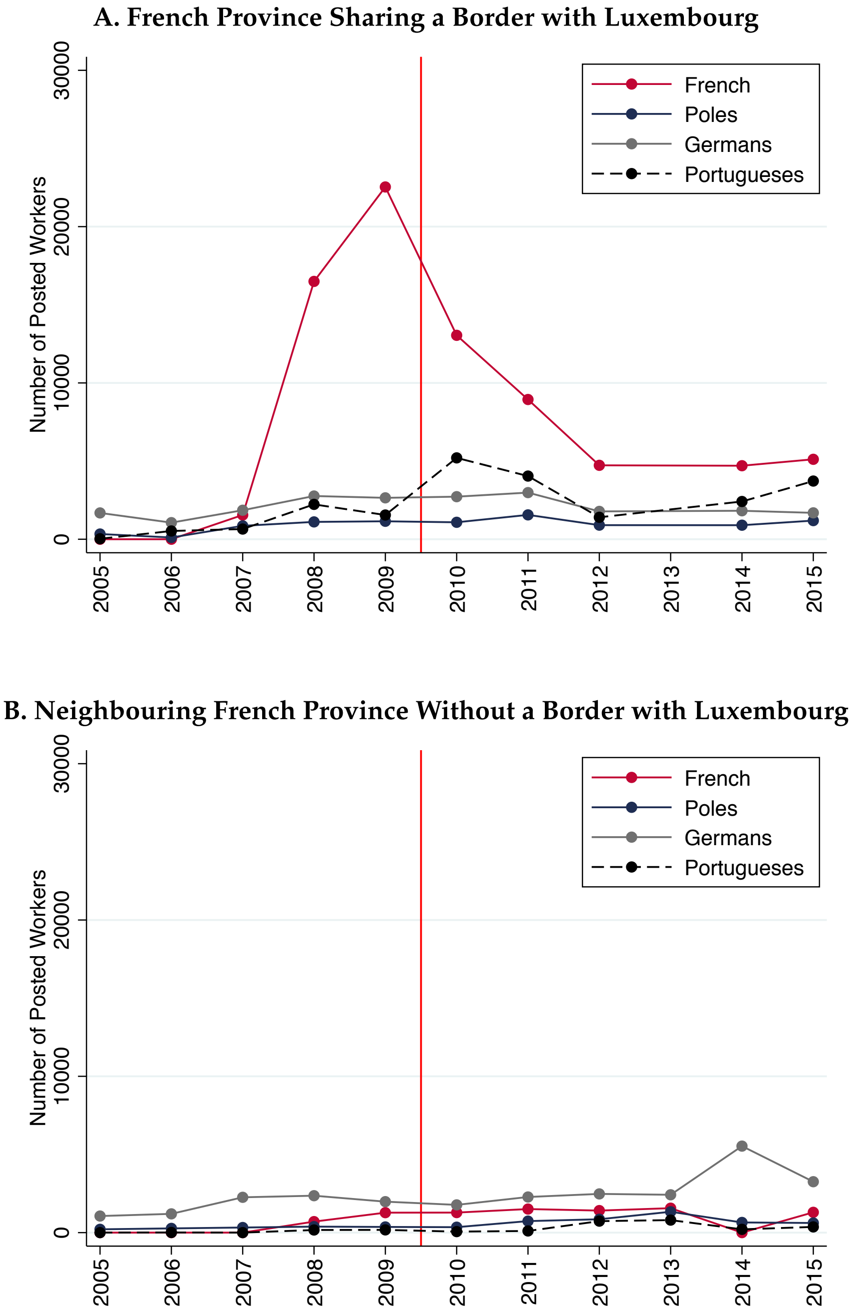
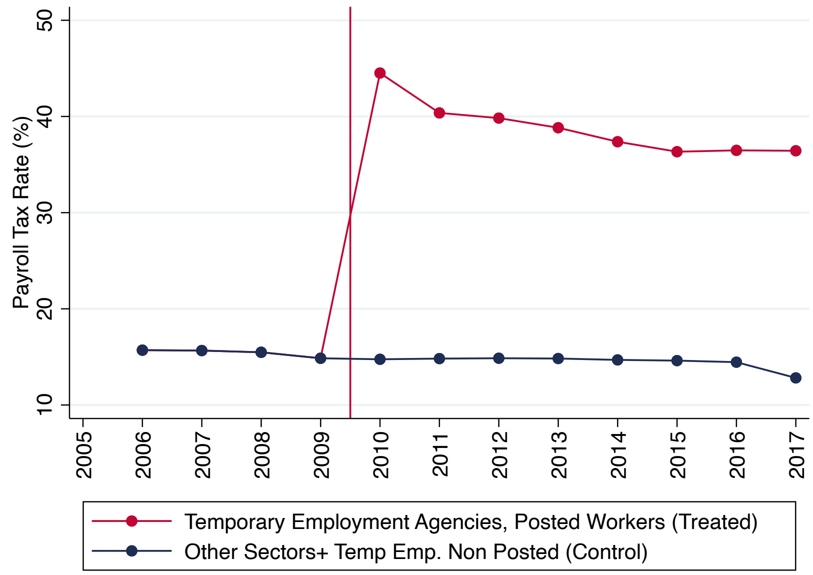


Figure B.3: **Effects of Destination-level Payroll Tax Exemption Reform on Received Postings**



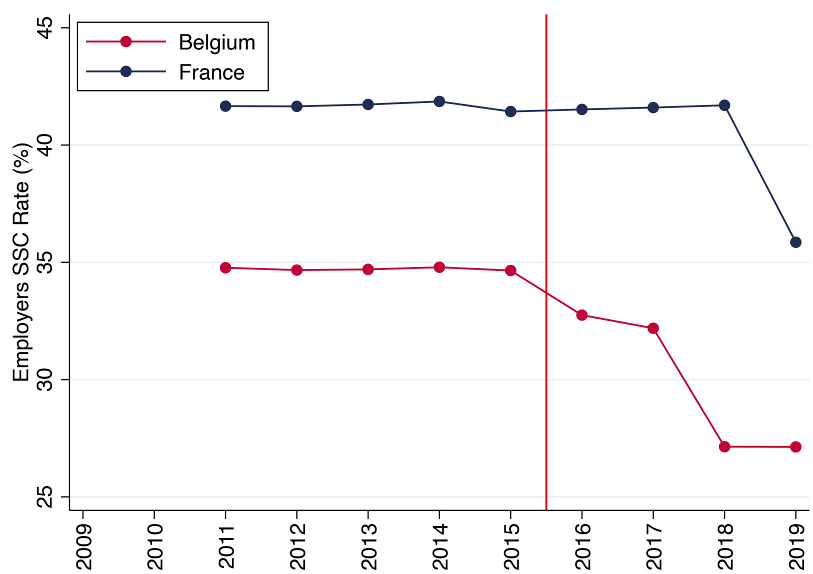
Notes: This Figure shows the effects of restricting posting-specific payroll tax exemptions in receiving countries. I study a reform that restricted labor cost exemptions granted for workers posted from temporary agencies located in Luxembourg. The reform was implemented in May 2010 and described in Appendix 2.4. French provinces close to Luxembourg were more exposed to this reform. The figures show the number of received posted workers in a French province that shares a border with Luxembourg (Moselle), before and after the reform (depicted by a vertical red line), by citizenship of workers posted to that province .Panel B shows received postings over the same period in a neighbouring province that does not share a border with Luxembourg (Meurthe et Moselle) and was thus less exposed to the reform.

Figure B.4: **Tax Arbitrage Reform and Payroll Tax Rate For Firms in Luxembourg**



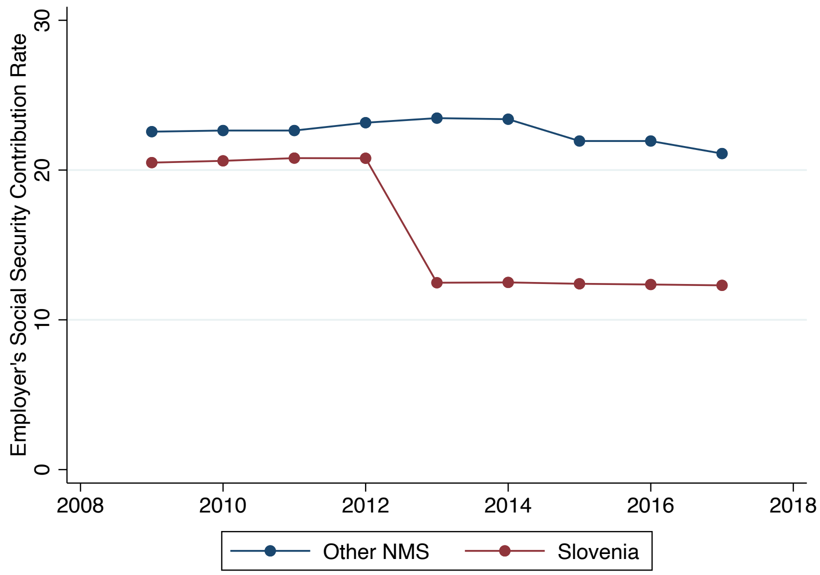
Notes: Thie Figure shows the evolution of payroll taxes paid by firms located in Luxembourg, before and after the implementation of the "tax arbitrage" reform in 2010.

Figure B.5: **Tax Shift in Belgium and Payroll Taxes**



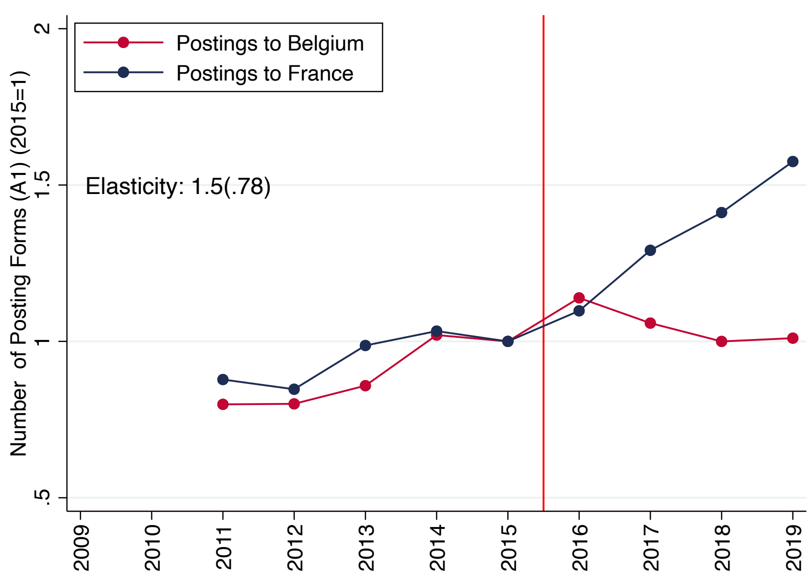
Notes: Thie Figure shows the evolution of payroll taxes paid by firms located in France and Belgium, before and after the implementation of the "tax shift" reform in Belgium in 2016.

Figure B.6: **Slovenian Posted Bonus and Payroll Tax Rate**



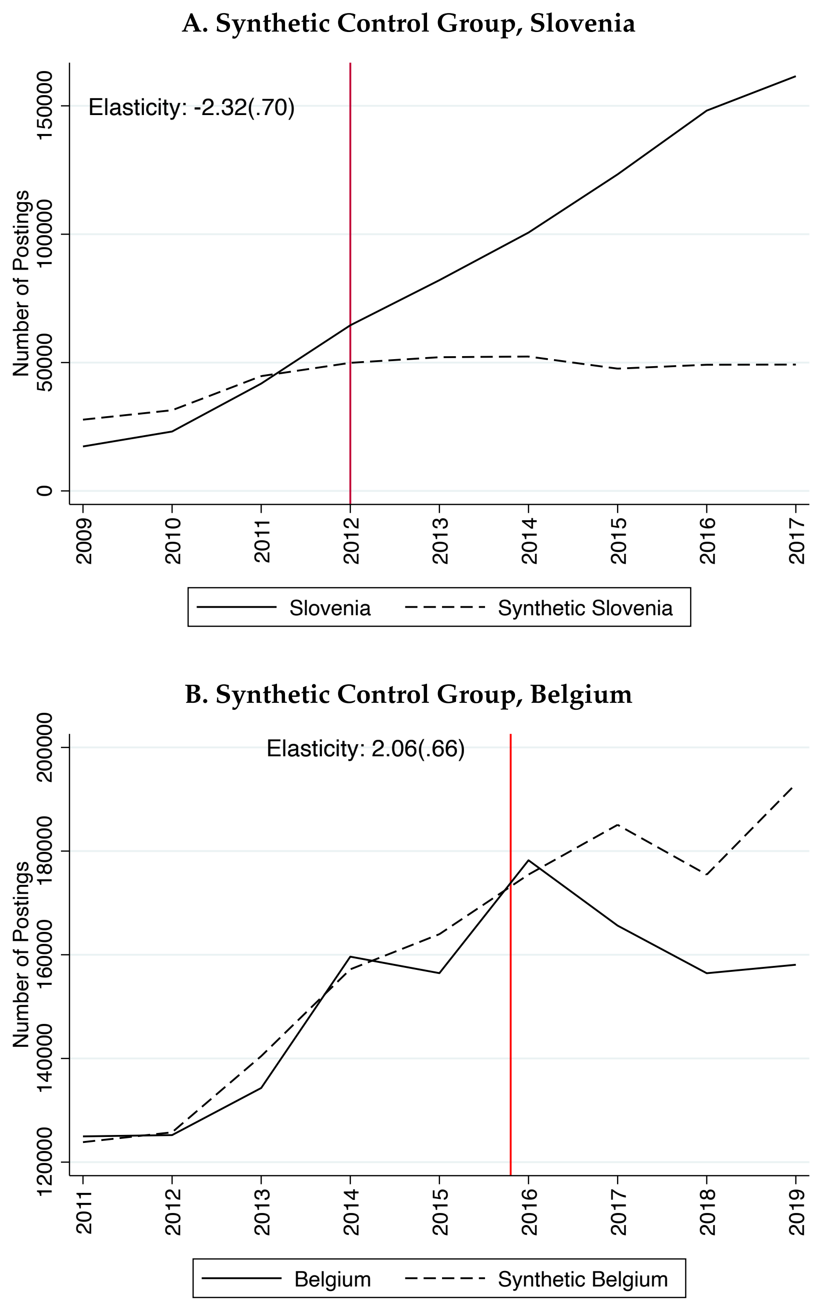
Notes: Thie Figure shows the evolution of payroll tax rates paid by firms located in Slovenia and other NMS before and after the new social security regulation of 2012.

Figure B.7: **Trade-Migration Responses to Tax Shift: Alternative Posting Dataset**



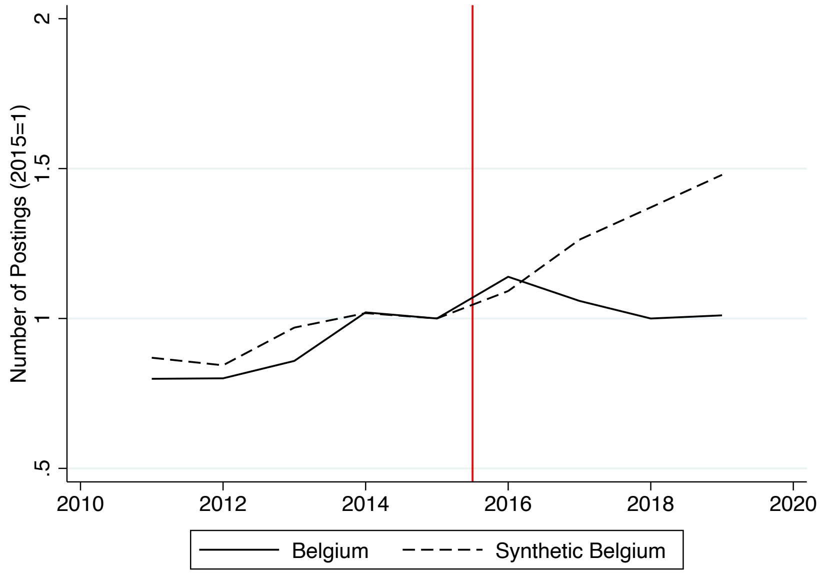
Notes: This Figure repeats the differencce-in-differences analysis of the Belgian tax shift reform, using an alternative dataset to measure flows of posted workers to Belgium and France. The dataset used in this figure is based on all social security forms for the posting of workers in all European countries (PDA1 forms), collected by the European Commission.

Figure B.8: **Trade-Migration Responses to Tax Shift: Synthetic Control**



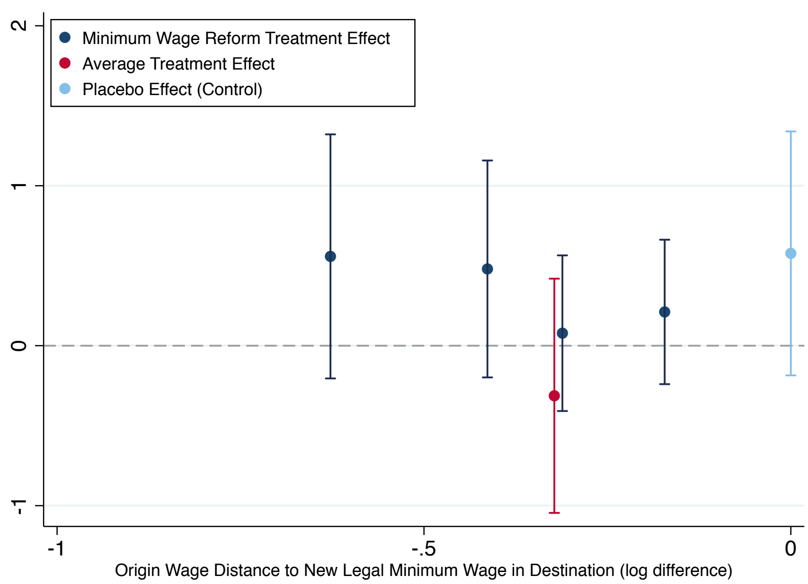
Notes: This Figure repeats the differencce-in-differences analysis of the Belgian tax shift reform, using the **?** synthetic control method to build a suitable control group for posting flows to Belgium. The top panel builds a synthetic control group matched on pre-reform posting trends. The bottom panel builds a synthetic control group based on pre-reform covariates such as labor cost, GDP and population.

Figure B.9: **Synthetic Control Group, Matched on Non-Posting Covariates**



Notes: This Figure repeats the differencce-in-differences analysis of the Belgian tax shift reform, using the **?** synthetic control method to build a suitable control group for posting flows to Belgium. The top panel builds a synthetic control group matched on pre-reform posting trends. The bottom panel builds a synthetic control group based on pre-reform covariates such as labor cost, GDP and population.

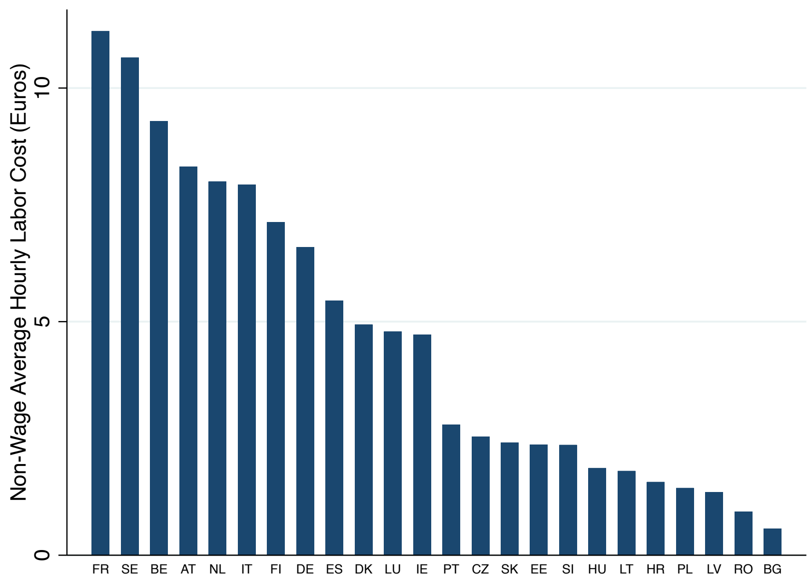
Figure B.10: **Trade-Migration Responses to Prevailing Cost Reform: Placebo Estimates**



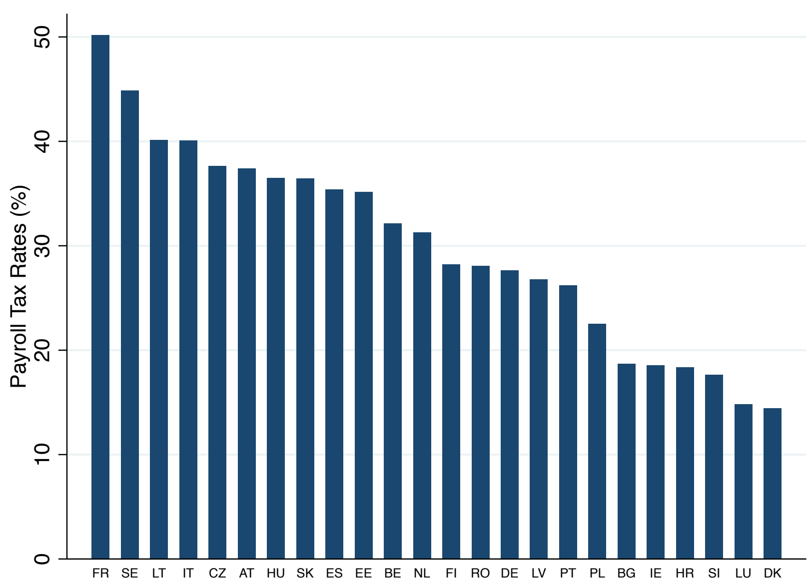
Notes: This Figure repeats the trople differences analysis of the minimum wage reform in Germany using the construction sector (not affected by the new posting allowance) as a placebo sector.

Figure B.11: **Non-Wage Labor Cost in Europe**

A. Average Hourly Labor Cost, Payroll Taxes (Euros)



B. Average Hourly Labor Cost, Payroll Taxes (% of Total)



Notes:

Table B.1: **Elasticity of Posting Flows to Policy-Induced Labor Cost Changes, Robustness**

	(1)	(2)	(3)	(4)
$-\theta$	-1.1***	-1.1***	-1.33***	-1.1***
	(.197)	(.236)	(.256)	(.204)
Observations	4,677	4,677	4,887	3,997
Robustness of Baseline to	Pair Clustering	Destination×Year, Origin×Year twoway cluster	Internal Flows	Zone Euro only

Notes: *p<0.10, **p<0.05, ***p<0.01.

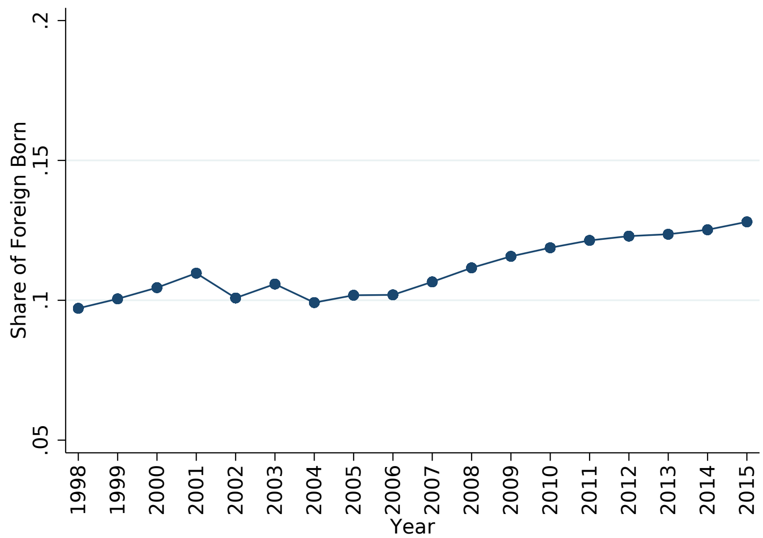
Appendix C

Do European Top Earners React to Taxation Through Migration?

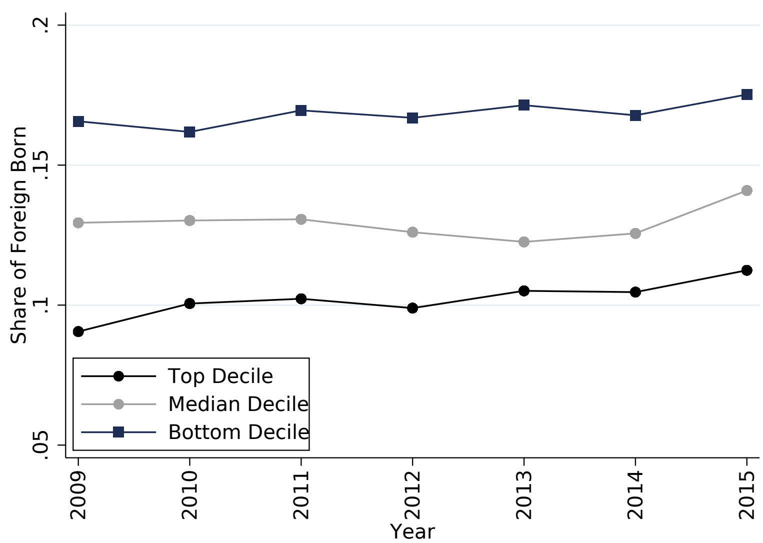
C.1 Additional Tables and Figures

Figure C.1: **Foreign-Born Residents in Europe**

A. Share of Foreign Born Residents in the European Union

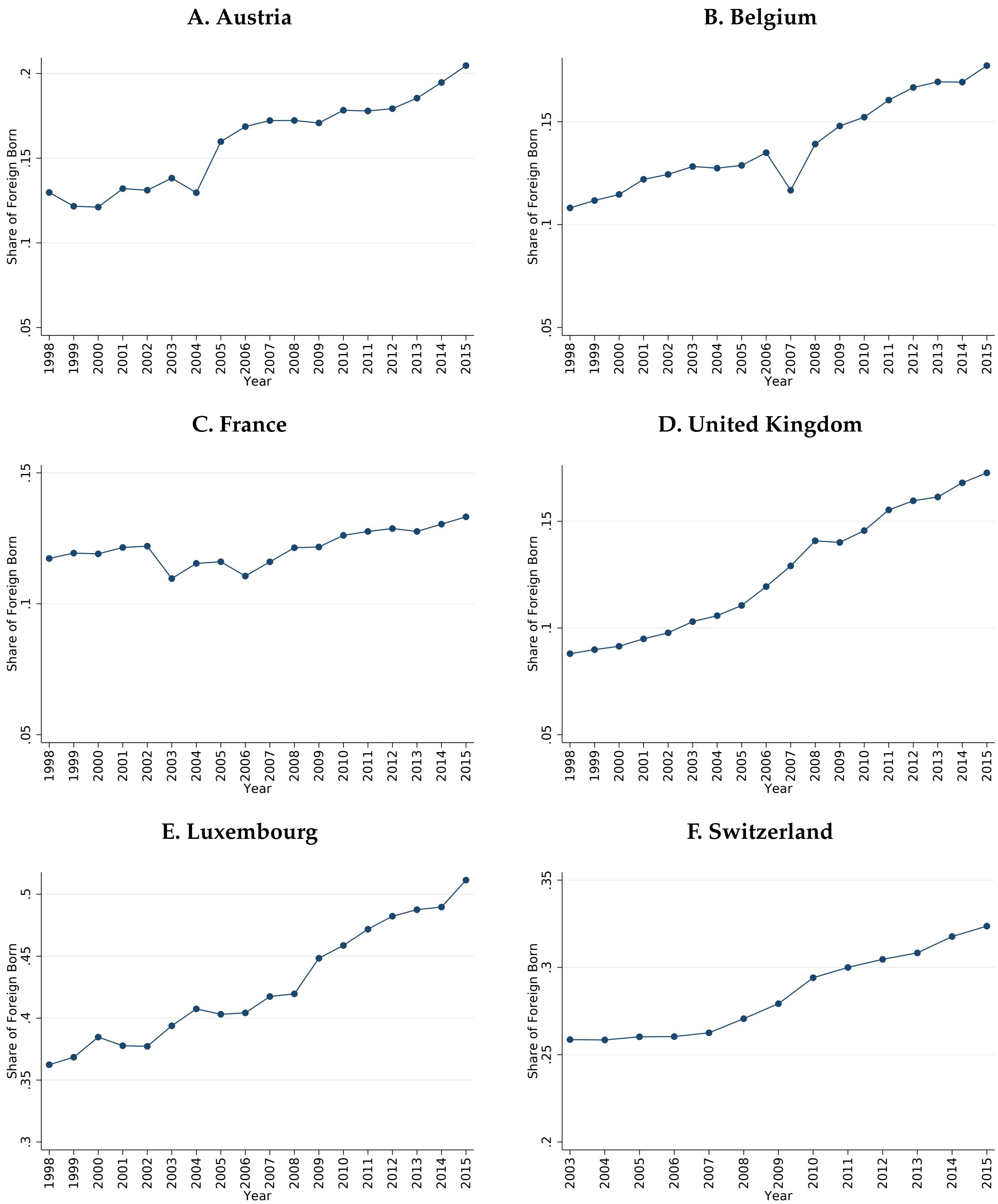


B. Share of Foreign Born Residents by Income Decile



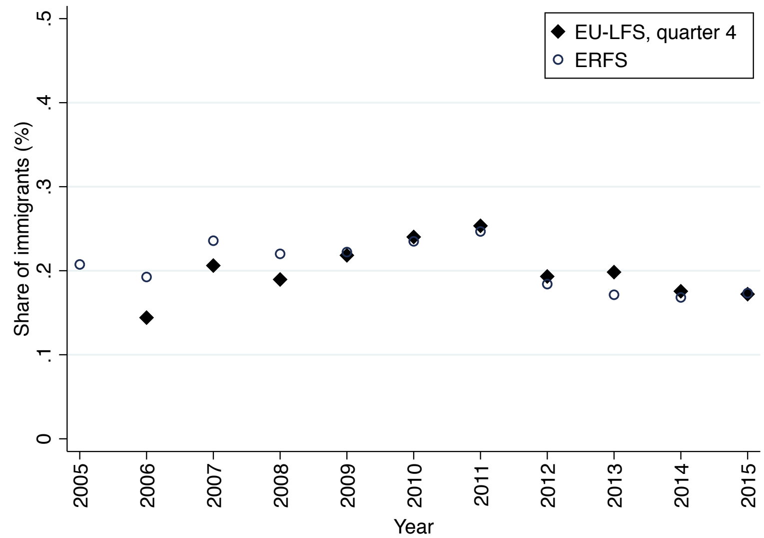
Notes: The Figure shows the evolution of the share of foreign-born residents in the working age population of the European Union. The definition of the European Union is dynamic and takes into account successive geographical enlargements. Panel A shows the evolution of the share of individuals whose age is between 18 and 62 years old who live in a country while being born in another country. Panel B shows the evolution of the share of foreign-born within income-decile population since 2009.

Figure C.2: **Share of Foreign-Born Residents Across European Countries Over Time**



Notes: The Figure depicts the evolution of the share of foreign born residents in the working age population of a selected number of European member states. Series are built from the EU-LFS as described with more details in the text, and the data appendix.

Figure C.3: **Consistency Between French Administrative Data and EU-LFS**



Notes: This Figure compares the EU-LFS measure of new residents flows with the same measure in the ERFS. ERFS is the merge between the last quarter of the French Labour Force Survey (the French part of the EU-LFS) and French administrative tax files. Only individuals surveyed in the labour force survey who actually filed an income tax return can be matched and found in the ERFS. Sample selection in both sources is individuals whose age is between 18 and 62 years old. Migration rate in the EU-LFS is computed as the number of individuals who were surveyed in France in year N and declared a different previous country of residence for N-1. Migration rate in the ERFS using the question in year N about previous residence in N-1 within and outside France (panswer "was living abroad" to the question "what was you residence last year"). Data plotted are raw and do not take into account representative survey weights. This is because the EU-LFS provides yearly-level data where weights are computed to assure the representativity of the sample at the yearly level. The ERFS provides quarterly weighting that ensures the representativity of the sample at the quarter level. Therefore, it is not possible to combine the yearly and the quarterly weights when using ERFS and EU-LFS datasets.

Table C.1: **Macro-Correlations Between Taxation and Migration**

	Top 10%			5th decile			1st decile		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
log(1-τ)	.84	.75	0.84	-0.96	-0.28	-0.96	.30	-.06	.30
s.e	(.72)	(.78)	(0.31)	(0.60)	(1.72)	(1.89)	(.96)	(1.0)	(0.47)
Observations	120	120	120	101	101	101	114	114	114
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	No	No	Yes	No	No	Yes	No	No
Time trend (linear)	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes

Notes: Each outcome variable at the country-year level is regressed in logs on the country's log GDP per capita, country fixed effects, year fixed effects, and the log retention rate, weighted by the population considered for each specification in each country and year. Column (1) of each specification gives the baseline specification, which includes country's log GDP per capita, country fixed effects, year fixed effects and clustered standard errors at the country-level. Column (2) adds a linear year trend to the baseline estimation. Column (3) relies on an alternative method for the clustering of the standard errors using the Discroll-Kray estimators that corrects for standard errors serial autocorrelation at the cross-sectionnal level.

Table C.2: **Location Choices of Movers**

	(1)	(2)	(3)
log(1-τ)$\times$ top 10%	1.88	2.57	2.99
s.e	(.62)	(.69)	(.96)
log(1-τ)$\times$ 5th decile	.30	1.01	1.44
s.e	(.70)	(.71)	(1.02)
log(1-τ)$\times$ 1st decile	-1.09	-.55	-.20
s.e	(.64)	(.66)	(.96)
Country FE	Yes	Yes	Yes
Covariates + Country FE	No	Yes	Yes
Covariates + Country FE x Year	No	No	Yes
Observations	86,204	83,935	83,935

Notes: Multinomial logit regressions with robust clustered standard error at the country of origin x year level in parentheses. This Table shows the estimates of the location choice model when the sample is restricted to movers only. See notes below Table 4 for details regarding the estimation and specification.

Table C.3: **Imputing Impatriates Schemes' Eligibility**

	(1)	(2)
log(1-τ)$\times$ top 10%	2.17	1.93
s.e	(.660)	(.682)
log(1-τ)$\times$ 8th	.552	.322
s.e	(.536)	(.593)
log(1-τ)$\times$ 5th decile	-.923	-1.11
s.e	(.526)	(.563)
Country FE	Yes	Yes
Covariates $\times$ Country FE	Yes	Yes
Country FE $\times$ Year	Yes	No
Country FE $\times$ Year FE	No	Yes
Observations	12,366,900	12,366,900

Notes: This Figure reproduces the baseline estimation of Table 3.7 imputing foreigners tax scheme eligibility in countries where such tax schemes have been implemented.

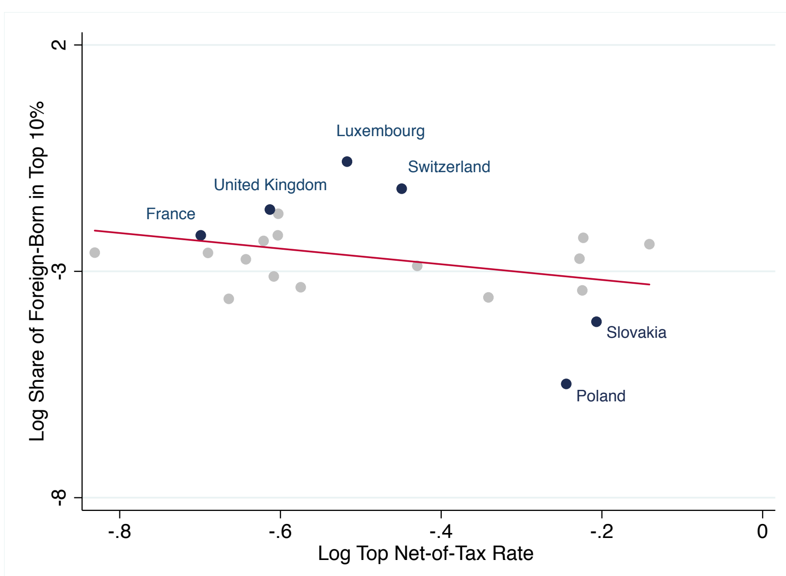
Table C.4: **Effect of Occupation Transition on Location Choices Sensitivity to Taxes**

	(1)	(2)
log(1-τ)$\times$ top 10%	3.44	4.372
s.e	(.908)	(1.545)
log(1-τ)$\times$ 5th decile	.593	1.56
s.e	(.750)	(1.43)
log(1-τ)$\times$ 1st decile	-.525	.373
s.e	(.818)	(1.51)
log(1-τ)$\times$ top 10%$\times$ self-employment shif	-4.11	-7.14
s.e	(5.50)	(6.16)
log(1-τ)$\times$ 5th decile$\times$ self-employment shift	4.43	1.66
s.e	(4.82)	(5.51)
log(1-τ)$\times$ 1st decile$\times$ self-employment shift	3.18	.219
s.e	(5.33)	(6.01)
Country FE	Yes	Yes
Covariates + Country FE	Yes	Yes
Covariates + Country FE x Year	No	Yes
Observations	10,635,981	10,635,981

Notes: Notes: Multinomial logit regressions with robust clustered standard error at the country of origin x year level in parentheses. This table presents the result from the specification used in Table 3.3 adding interaction terms between earnings decile and change of occupation between employment and self-employment. The subsample of estimation is randomly selected from the original estimation sample for computational issues.

Figure C.4: **Macro-Level Correlations Between Top Tax Rates and Foreigners**

A. Share of Foreign-Born Within Top Decile



B. Share of New Residents Within Top Decile

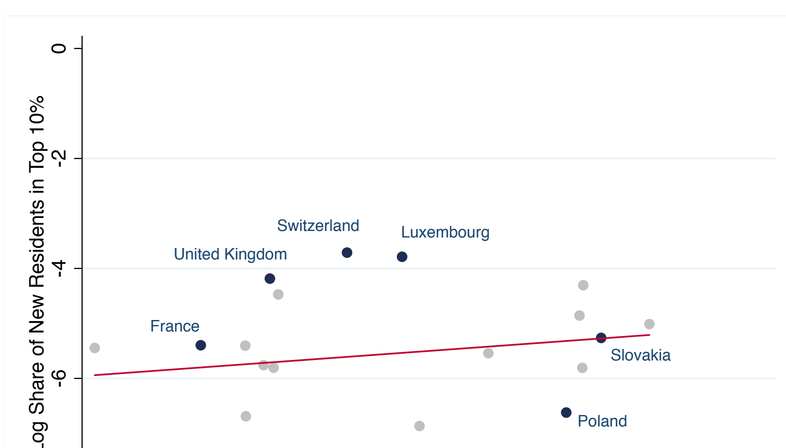
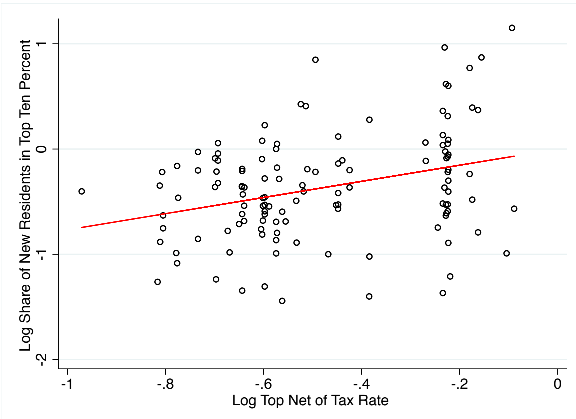
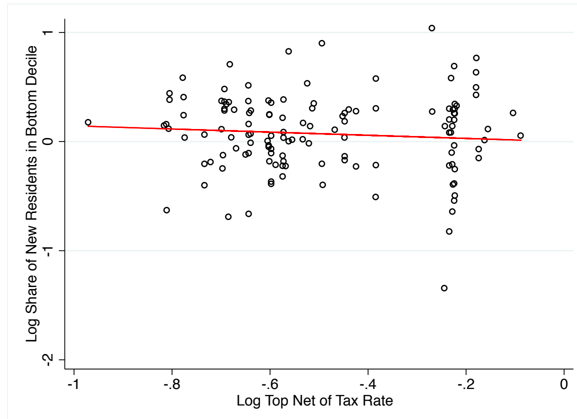


Figure C.5: **Cross-Country Correlations Between Taxation and Migration, 2009-2015**

A. Top Decile



B. Bottom Decile



Notes: Each outcome variable at the country-year level is regressed in logs on the country's GDP per capita, country fixed effects, year fixed effects, and the log retention rate, weighted by the number of top earners in each country and year. Each scatter point represents the adjusted log outcome (the log outcome from which I substract all covariates except the taxation rate) times their estimated coefficients. Linear regression lines are depicted. For the upper figures, Panel A shows the share of new residents (foreigners) in the national top decile of the wage distribution (number of top 10 percent new residents divided by the overall number of top ten percent employees in that country). Panel B considers the share of foreign bottom earners (sum of foreigners in the first decile of the wage distribution divided by the total number of individuals in the first decile in that country).

C.2 Derivation of Formulas for Calibrations

In this section, I simply derive the revenue maximizing linear-rate in the presence of tax competition. As it is standard in the literature, individuals are characterized by their skills w and their preferences over leisure and labour. They derive an utility $u^i(c, y)$ that is increasing in consumption c, and decreasing in earnings, as earnings require more effort, and individuals have a disutility for work. There is a mass N_i of type-i individuals in the economy. I consider for simplicity a government that sets in each period a linear tax rate τ in order to raise an amount $R = \tau Y$, where Y denotes aggregated earnings $Y = \sum_i N_i y_i$. The tax revenue is redistributed to everyone as a lumpsum T_0.

I make the assumption that individuals can respond to taxation only through migration. I define the migration elasticity as the change in the number of type-i individuals when the net-of-tax rate faced by these individuals is increased $\varepsilon_i = (\partial N_i / \partial(1-\tau)) \times (1-\tau) \times N_i$.

In the case where the government cannot impose a differential rate on foreigners, it simply maximizes for each period $R = \tau \sum_i N_i y_i$ where both N_i and y_i are a function of the uniform net-of-tax rate. The optimal tax can be easily retrieved by studying a small deviation in the tax schedule τ. Consider an infra-marginal change in the uniform linear tax schedule $d\tau$. The small tax deviations induces a change in the government tax revenue equal to $d\tau Y$, due to a mechanical increase in tax revenue. Individuals have an extensive margin of response to the tax change through migration. Individuals react to $d\tau$ through the migration effect $-\varepsilon \frac{\tau}{1-\tau} Y d\tau$, that captures mobility response to the net effect of the reform on their post-tax earnings. The total effect on tax revenue is therefore given by $dR = (1 - \varepsilon \frac{\tau}{1-\tau}) Y d\tau$ in the competing union. Summing behavioural and mechanical effects to zero yields the inverse tax rate formula for the Laffer rate that maximizes tax revenue.[1]

The proof is similar in the case where the government discriminates foreigners. In that case, the government maximizes the revenues collected on foreigners separately, meaning that it sets τ_f that maximizes the revenue raised on the set of foreigners $R_f = \tau_f \sum_{i \in F} N_i y_i$. The small tax deviation approach yields the same inverse formula with alternative elasticities that are now evaluated for each subgroup of taxpayers.

The derivation of the behavioural burden is straightforward. Denoting dM the mechanical change in tax revenue after a small tax reform, we can write in the case of the uniform tax rate $dR = (1 - \varepsilon \frac{\tau}{1-\tau}) dM$.

[1] The derivation of the optimal tax formulas specifying the entire maximization problem are detailed in **?**. It also emphasizes how the revenue-maximizing rate is theoretically different from the Rawlsian rate in the case of migration. In that case, the optimal tax rate is augmented by a transfer-weighted term.

C.3 Data Appendix

C.3.1 Mobility Data

The EU-LFS is the largest European survey providing annual micro data on the labour participation of people aged 15 and more, in and outside the labour force. It is conducted every year in 33 participating countries: the 28 members of the Union, the three EFTA countries (Switzerland, Norway, and Iceland) and two candidate countries (former Republic of Macedonia and Turkey). It is designed as a continuous quarterly survey since 2004, with interviews spread uniformly over all weeks of a quarter. The participation in the EU-LFS for surveyed individuals is compulsory for fourteen of the participating countries. On average, the achieved sampling rate in the EU-LFS is approximately 0.3% of the total European population. Surveys are implemented by National Statistics Institutes, and aggregated by Eurostat, which also corrects for non-responses and applies yearly weighting methods. This allows to use the survey at the yearly level and to conduct cross-country comparisons. Population registers, latest population census and lists of addresses are the main sources for the sampling frame, and on average, the achieved sampling rate in the EU-LFS is approximately 0.3% of the total European population.[2]

The information on individuals' nationality and past residence is available since 1995, and allows us to select non-citizens and new residents, that I define alternatively as "foreign-born" and "foreigners". The main limitation of the data relates to the aggregation of the citizenship variable for foreigners. This implies that for foreign-born, and foreign citizens residents, it is not possible to observe their exact origin. It theorefore provides to infer for these individuals their counterfactual residence if they would live at "home". The data allows to identify a German residing in France as a foreigner, but does not enable to identify Germany as its origin country. Therefore, the residence-based definition foreigners is used in the estimation, as it is the only measure allowing to control for home bias for individuals who do not live in their home country. Each member state is also to publish compulsory yearly quality reports documenting sampling errors, non-response rates and general remarks about the quality of the data provided by the survey.

Regarding information on income and taxes paid, the EU-LFS provides the decile of labor earnings for surveyed earners since 2009. Information on the level of earners' monthly labor earnings is collected during the interview, but is not provided in the micro-data. The LFS instead directly provides the income decile of each earner. Importantly, this decile is based on labor income only, and does not take into account any other source of income, such as capital income. In addition to information on citizenship, current and past residence and income decile, the survey offers a large set of precisely measure individual-level covariates. These variables include age, gender, family status, number of children, size of the firm, sector of occupation, highest level of education acchieved, field of the education degree, presence or not of supervisory responsibilities in the job, number of weekly hours of work, information on past labour market status or unemployment, existence of other jobs, NUTS2 region of residence, and many other characteristics.

[2] Sampling rates vary across countries and years. For instance, in 2013, the EU-LFS sampling rate was 4% of the overall population for Luxembourg, against 0.3% for France.

C.3.2 Top Marginal Tax Rates Data

I complete the mobility dataset with data on top marginal tax rate collected from the OECD Taxing Wages Database. The main measure I use is the combined central government and sub-central government marginal personal income tax rate at the earnings threshold where the top statutory personal income tax rate first applies. It is calculated as the additional central and sub-central government personal income tax resulting from a unit increase in gross wage earnings. The combined rate takes account of the effects of tax credits, the deductibility of sub-central taxes in central government taxes, etc. I build an alternative measure of the top marginal tax rate that takes into account social security contribution rates on employers and employees at the top of the income distribution. For this measure, I use the social security contributions rates paid by employers and employees at an income level that is 5 times higher than the average wage, and that are provided by the OECD Taxing Wages

C.4 Cross-Country Analysis

Level-Level Correlations I start by asking: do European countries with lower levels of top income tax rates have higher numer of foreign-born and immigrants in their top earners' population? To answer this question, I study the correlation between the average level of top marginal tax rate and the number of foreign-born residents and new residents in the top decile over the period 2009-2015. Figure C.4 shows a negative (but not significant) correlation between the share of foreign-born among the population of top earners and the level of top tax rates (Panel A), and a zero correlation between the share of new-residents among the population of top earners and the level of top tax rates (Panel B). Contrary to the prediction of Equation (3.2), European countries with higher share of foreign born in their top decile tend to have higher levels of top marginal tax rates. For instance, Eastern Europe countries are characterized by low level of top tax rates but low level of both foreign born and new residents among their top taxpayers population. By constrast, some countries like France or Belgium have relatively high levels of top tax rates and much higher share of foreign born and new residents within their population of top earners. Of course, these differences are driven by countries specific characteristics included in Γ^k_{nt} and that are controlled for in the simple level-level correlation. This exercise illustrates that there are many other factors than taxes that may determine the number of top earners who were born (or are coming from) abroad in one country, and these factors may sometimes completely dominate tax differentials. To properly identify the effects of top income tax rates on top earners' mobility, it is important to control for any factors that could affect the variation in levels of top tax rates on the one hand, and the number of foreign born or new residents among top taxpayers on the another hand.

Country-by-Year Variations in Top Marginal Rax Rates I therefore complement the level-level correlations by studying the effects of country-year variations in top marginal tax rates and top earners migration flows, controlling for country and year fixed effects in order to eliminate time-invariant (γ_n) and time-specific factors (γ_t) that could affect top tax rates and top earners mobility flows. To partially capture country-time-varying potential confounders γ_{nt}, I also control for GDP per capita and a linear time-trend. Here, the question asked is: conditional on countries permanent characteritics and year-specific shocks, are variations in top marginal tax rates correlated with variations in top earners' immigration flows? The results summarized in Table C.1 show a positive correlation between the log share of new residents within the top decile and the log net-of-tax retention rate, while the correlation is flat when reproducing the same exercise for individuals in the bottom half of the earnings distribution, who are not affected by top tax rates variations (Figure C.5). The exercise shows that controlling for time-invariant factors and time-specific factors leads to a positive correlation between change in top retention rate and number of top earners' new residents, while the correlation is not verified for bottom earners not affected by changes in top marginal tax rates.

Appendix D

How Much Are the Poor Losing from Tax Competition

D.1 Proofs

D.1.1 Revenue-Maximizing Linear Tax Rate

Federal Government The federal government maximises the tax revenue function, that does not depend on the number of taxpayers because of the absence of tax-driven migration in the federal union. For notation purposes, I present the problem such that there are N_i individuals characterised by preferences $u^i(c, y)$, and Y denotes the sum of earnings' function over individuals with various preferences $Y = \sum_i N_i y_i$.

The first order condition with respect to goverment rax revenue $R = \sum_i N_i y_i (1-\tau)\tau = Y(1-\tau)\tau$ is given by $(d\tau/d\tau)Y - (dY/d(1-\tau))\tau = 0$. Using the definition of the labour supply elasticity,we can show that:

$$\tau^f = \frac{1}{1+e}$$

Where e is the income weighted elasiticities such that $e = \sum \frac{N_i y_i}{Y} e_i$.

Competing Government In the presence of tax competition, the number of taxpayers becomes a function of the net-of-tax rate determined in tax competition. As a result, the government tax revenue can be written $R = \sum_i N_i(1-\tau) y_i(1-\tau)\tau$. The first order condition with respect to the tax rate is $\sum_i [(d\tau/d\tau) y_i N_i - (dy_i/d(1-\tau))\tau N_i - (dN_i/d(1-\tau))\tau y_i] = 0$. Using the definition of ε_i and e_i, we obtain:

$$\tau^f = \frac{1}{1+e+\varepsilon}$$

Where is e and ε are the income weighted elasiticities such that $e = \sum_i \frac{y_i N_i}{Y} e_i$ and $\varepsilon = \sum_i \frac{y_i N_i}{Y} \varepsilon_i$. The optimal tax can be easily retrieved by studying a small deviation in the tax schedule τ. Consider an infra-marginal change in the linear tax schedule $d\tau$. The small tax deviations induces a change in the government tax revenue equal to $d\tau Y$, due to a mechanical increase in tax revenue. As pre-tax earnings are endogeneously determined by a labour-leisure trade-off, the reform causes an aggregated change in earnings $-e\frac{\tau}{1-\tau}Yd\tau$. In the presence of tax competition, individuals have an extensive margin of response to the tax change through migration. Individuals react to $d\tau$ through an additional migration effect $-\varepsilon\frac{\tau}{1-\tau}Yd\tau$, that captures mobility response to the net effect of the reform on their post-tax earnings. The total effect on tax revenue is therefore given by $dR = (1 - e\frac{\tau}{1-\tau} - \varepsilon\frac{\tau}{1-\tau})Yd\tau$ in the competing union, and $dR = (1 - e\frac{\tau}{1-\tau})Yd\tau$ in the federal union. Summing behavioural and mechanical effects to zero yields the inverse tax rate formula for the Laffer rate that maximizes tax revenue.

D.1.2 Transfer Maximizing Rate

Let's now consider the case where the government wants to maximize the amount of transfer to the poorest individuals (that is to say the government is Rawlsian). In the absence of tax competition, the population can always be normalized to one without loss of generality, and the revenue-maximizing rate corresponds to the optimal linear rate chosen by the Rawlsian government. In the presence of tax competition, individuals are able to respond to taxation trough migration, and the absolute number of taxpayers may be changed by these migration responses. Therefore, the amount that can be redistributed to individuals can be indirectly affected by the number of individuals in the country through the tax-driven migration channel. As a result, when the absolute number of taxpayers in changed by a change in the linear tax rate, the Ralwsian linear rate is no longer equivalent to the revenue-maximizing rate. The optimal linear rate of the Rawlsian government maximizes $T_0 = \frac{1}{N}\sum_i \tau y_i N_i$. Denoting $R = \sum_i \tau y_i N_i$, the first order condition with respect to τ is given by $\frac{dR \times N - dN \times R}{N^2}$. Formally, the FOC is:

$$\frac{1}{N}(\sum_i y_i N_i - \sum_i \frac{\tau}{1-\tau} e_i y_i N_i - \sum_i \frac{\tau}{1-\tau}\varepsilon_i y_i N_i) + \frac{1}{N^2}(\sum_i \frac{\tau}{1-\tau}\varepsilon_i N_i \sum_i y_i N_i) = 0 \tag{D.1}$$

The equation can be rewritten as

$$1 - \sum_i \frac{\tau}{1-\tau}\frac{e_i N_i y_i}{Y} - \sum_i \frac{\tau}{1-\tau}\frac{\varepsilon_i y_i N_i}{Y}) + \frac{1}{N}\sum \frac{\tau}{1-\tau}\varepsilon_i N_i = 0$$

And it follows that the linear tax rate that maximizes the amount of transfer is given by

$$\frac{\tau}{1-\tau} = \frac{1}{e+\bar{\varepsilon}}$$

Where $e = \sum \frac{N_i y_i}{Y} e_i$ and $\bar{\varepsilon} = \sum \frac{N_i y_i}{Y}\varepsilon_i - \sum_i \frac{N_i}{N}\varepsilon_i$.

D.1.3 Optimal Linear Tax Rate with Welfare Weights

In this section, I consider the case where the government maximizes the total welfare in a country. The welfare function is modeled as a sum of weighted utilities, where the welfare weights capture the social preferences of the government, and are exogeneously determined. In each country, there is a mass N_i of type-i individuals characterized by the same preferences and the same income y_i. In the federal symmetric union, the size of the population does not matter for the welfare maximization and can always be normalized to one without loss of generalities. Without tax-driven migration, the welfare maximized is always the welfare of individuals located in the country, as location choices are exogeneous to the coordinated tax policy. Any change in the tax rate will not affect the government welfare function through the number of individuals entering in this sum. In a free mobility union with competing countries, the maximization of total welfare for the optimal tax policy becomes less evident, as the competing government could aim to maximize the welfare of its nationals, initial residents, or may want to take into account the welfare of residents arriving after a change in the tax rate. The issues related to which individuals should be included in the social welfare functions of competing countries is normative, and beyond the scope of this paper. I discuss below two alternative welfare functions and their implications for the optimal linear tax rate set at the optimuum.

Formally, the government attributes a general welfare weight g_i to the utility of type i individuals in the economy such that the optimal linear tax rate maximizes $\sum_i N_i g_i u_i(c_i, y_i)$. Because of the envelop theorem, the government can ignore the effect of τ through y_i at the optimum. When countries compete, the density N_i is affected by tax policy. Therefore, the total welfare of the government may be affected through two channels by tax competition. The sum of weighted utilities may be changed by *(i)* the intensive change in welfare through the change in taxes paid and transfers received but also through *(ii)* the extensive change in the number of individuals that enter in the welfare maximization of the government due to migration responses to taxation. This can be simply observed by taking the first order condition of the government social welfare function with respect to $1-\tau$:

$$-\sum_i N_i g_i \frac{\partial u_i(c_i)}{\partial(1-\tau)} - \sum_i g_i u_i(c_i) \frac{\partial N_i}{\partial(1-\tau)} \tag{D.2}$$

The first term captures the effect of tax-driven migration on the level of consumption in the country, because mobility responses to taxation affect (1) taxes collected by the government and (2) the number of individuals in the country who have to split the amount collected by the government. The second term captures the effect of mobility responses to taxation of the number of individuals entering in the welfare function of the government. In the case where the welfare maximization is endogeneous to the population changes, the government may have the incentives to increase the number of taxpayers to increase the total welfare in the economy. Said differently, the government could have the incentive to maximize the amount of individuals entering in the country in order to maximize the total sum of welfare, rather than maximizing the amount of welfare for a given population size.

In the main specification, I ignore the second term of Equation (D.2) in order to avoid considerations related to the size of the population that maximizes the weighted sum of utilities. Rather, I consider a government that maximizes the welfare of a given population N_i, that is endogeneously determined in equilibrium, but that is taken as given for the welfare aggregation. With this specification, the number of individuals leaving country A only affect the total welfare in country A through the effect of their migration on the level of tax revenue and transfer for individuals residing in country A. The fact that individuals leave country A and thus the total welfare of country A does not matter, the government only cares about individuals residing in country A. Similarly, the total welfare in country A cannot be increased by the entry of new residents would increase the total welfare in country A by increasing the number of individuals entering in the sum. In spirit, this approach would consist in a government that maximizes the welfare of non-movers, taking into account the effect of movers on non movers utility through the revenue and transfer effects. Using the quasi-linearity in consumption because of the absence of income effects, it is possible to write the first order condition with respect to the linear tax rate as:

$$\sum N_i g_i(-y_i + \frac{1}{N}(Y - \sum_i \frac{\tau}{1-\tau} e_i y_i N_i - \sum_i \frac{\tau}{1-\tau} \varepsilon_i y_i N_i) + \frac{Y}{N^2} \sum_i \frac{\tau}{1-\tau} N_i \varepsilon_i) = 0 \tag{D.3}$$

$$\sum_i N_i g_i y_i . \sum_i N_i = \sum_i N_i g_i (Y - \sum_i \frac{\tau}{1-\tau} e_i y_i N_i - \sum_i \frac{\tau}{1-\tau} \varepsilon_i y_i N_i + Y \sum_i \frac{\tau}{1-\tau} \frac{N_i}{N} \varepsilon_i$$

$$\frac{\sum_i N_i g_i y_i . \sum_i N_i}{(\sum_i N_i Y_i) . \sum_i N_i g_i} = 1 - \frac{\tau}{1-\tau} e - \frac{\tau}{1-\tau} \bar{\varepsilon} \tag{D.4}$$

Denoting $\bar{g} = \frac{\sum N_i g_i y_i . N}{Y . \sum N_i g_i}$, we obtain the optimal linear tax rate formula $\tau^c = \frac{1-\bar{g}}{1-\bar{g}+e+\bar{\varepsilon}}$ where $\bar{\varepsilon}$ is a combination of the income weighted migration elasticity $\varepsilon = \sum_i \frac{N_i y_i \varepsilon_i}{Y}$ and the population-weighted migration elasticity $\varepsilon_p = \sum_i \frac{N_i \varepsilon_i}{N}$. In the case where the absolute number of taxpayers is unchanged by tax-driven migration (only the composition of the population changes), the population-weighted elasiticity is zero, and the optimal linear tax rate only depends on the standard income-weighted average mobility parameter ε, similarly than for the revenue-maximizing government. Importantly, the terms $\sum N_i g_i y_i$ and $\sum N_i g_i$ of the average welfare weight $\bar{g}$ depends on the densities that are taken as exogeneous in the government for the welfare aggregation (for instance, densities of stayers).

Endogeneous Size of the Welfare Sum Let's now explore the case where the government maximizes the sum of weighted utilities taking into account the change in the composition of the population and thus the set of individuals entering in the sum of welfare. With the envelop theorem and quasi-linearity in consumption, this is equivalent to $\sum_i N_i g_i \left[(1-\tau) y_i + \frac{\tau \sum_i N_i y_i}{\sum_i N_i}\right]$. The first order condition of the government with respect to τ would be given by $\sum_i N_i g_i \frac{\partial u_i(c_i)}{\partial \tau} + \sum_i g_i u_i(c_i) \frac{N_i}{\partial \tau}$. With these social preferences, the endogeneous change of N_i caused by tax-driven mobility will affect the total welfare through its effect on taxes and transfer as captured by Equation (D.3), and an additional effect through the change in the number of individuals who compose the welfare sum in equilibrium. The first order condition is more precisely given by:

$$\sum_i N_i g_i \left(-y_i + \frac{1}{N} \left[Y - \sum_i \frac{\tau}{1-\tau} e_i y_i N_i - \sum_i \frac{\tau}{1-\tau} \varepsilon_i y_i N_i \right] + \frac{Y}{N^2} \sum_i \frac{\tau}{1-\tau} N_i \varepsilon_i \right) - \sum_i g_i u_i(c_i, y_i) \frac{\partial N_i}{d(1-\tau)} = 0 \tag{D.5}$$

As in the previous section, the first term of Equation (D.5) captures the effect of tax-driven migration on welfare through its effects on residents' consumption: *(i)* a change in taxes paid *(ii)* a change in the amount of transfers received because of change in tax liabilities (*revenue effect*) and change in absolute number of transfer beneficiaries (*transfer channel*). The formula is augmented by an additional term capturing the effect of tax-driven migration of the amount of individuals who enter in the total welfare of the country. The underlying intuition is that any change in the tax rate τ causes a change in the total welfare through the amount of individuals who leave the country and somehow *"take their welfare"* with them. This effect is of magnitude $\frac{\partial N_i}{d(1-\tau)}$ that captures the magnitude of migration responses to taxation, and has a welfare cost $g_i u_i$ as any type-i individual leaving the country decreases the sum of total welfare by its consumption weighted by its corresponding welfare weight. Note that for individuals below the break even point, N_i is an increasing function of the net-of-tax rate, and therefore an increase in τ increases the total welfare by including immigrants in the welfare sum. The FOC of the government can be rewritten:

$$\sum_i N_i g_i \left(-y_i + \frac{1}{N} \left[Y - \sum_i \frac{\tau}{1-\tau} e_i y_i N_i - \sum_i \frac{\tau}{1-\tau} \varepsilon_i y_i N_i \right] + \frac{Y}{N^2} \sum_i \frac{\tau}{1-\tau} N_i \varepsilon_i \right) - \sum_i g_i u_i(c_i, y_i) \frac{N_i}{1-\tau} \varepsilon_i = 0$$

$$\sum_i N_i g_i \left(-y_i + \frac{1}{N} \left[Y - \sum_i \frac{\tau}{1-\tau} e_i y_i N_i - \sum_i \frac{\tau}{1-\tau} \varepsilon_i y_i N_i \right] + \frac{Y}{N^2} \sum_i \frac{\tau}{1-\tau} N_i \varepsilon_i \right) - \sum_i g_i \frac{N_i}{1-\tau} \varepsilon_i \left[(1-\tau) y_i + \tau Y/N \right] = 0$$

$$\sum_i N_i g_i \left(-y_i + \frac{1}{N} \left[Y - \sum_i \frac{\tau}{1-\tau} e_i y_i N_i - \sum_i \frac{\tau}{1-\tau} \varepsilon_i y_i N_i \right] + \frac{Y}{N^2} \sum_i \frac{\tau}{1-\tau} N_i \varepsilon_i \right) - \sum_i g_i N_i \varepsilon_i y_i - \sum_i g_i N_i \frac{\tau}{1-\tau} \varepsilon_i \frac{Y}{N}) = 0$$

$$\sum_i N_i g_i y_i (1+\varepsilon_i) = \sum_i N_i g_i \left(\frac{1}{N} \left[Y - \sum_i \frac{\tau}{1-\tau} e_i y_i N_i - \sum_i \frac{\tau}{1-\tau} \varepsilon_i y_i N_i \right] + \frac{Y}{N^2} \sum_i \frac{\tau}{1-\tau} N_i \varepsilon_i \right) - \sum_i N_i g_i \frac{\tau}{1-\tau} \varepsilon_i \frac{Y}{N}$$

$$\frac{\sum_i N_i g_i y_i (1+\varepsilon_i) \times N}{\sum N_i y_i} = \sum_i N_i g_i \times \left(1 - \frac{\tau}{1-\tau} e - \frac{\tau}{1-\tau} \varepsilon + \sum_i \frac{\tau}{1-\tau} \frac{N_i}{N} \varepsilon_i \right) - \frac{\tau}{1-\tau} \sum_i N_i g_i \varepsilon_i$$

$$\frac{\sum_i N_i g_i y_i (1+\varepsilon_i) \times N}{\sum N_i y_i . \sum_i N_i g_i} = 1 - \frac{\tau}{1-\tau} \left(e - \varepsilon + \varepsilon_p - \sum_i \frac{N_i g_i \varepsilon_i}{\sum_i N_i g_i} \right) \tag{D.6}$$

How is the optimal linear tax rate changed if the size of the welfare sum, or said differently the population that is taken into account in the total welfare of one country, is changed by taxation? There is a first change through the average welfare weight parameter, that is now affected by the migration elasticity. The welfare weight of individuals is augmented (or lowered) by the strength of their mobility elasticity. The optimal tax rate is also directly affected by an additional term $\varepsilon_w = \sum_i \frac{N_i g_i \varepsilon_i}{\sum_i N_i g_i}$ that is a *welfare-weighted average mobility elasticity*, capturing the effect of tax-driven mobility on total welfare through its effect on the number of individuals included in the welfare definition. For individuals with a negative mobility elasticity, this term is positive, meaning that the government has incentives to *increase* the linear tax rate in order to attract bottom earners and to capture their additional welfare. To summarize, when the government maximizes the total welfare in the country by also maximizing the amount of individuals included in the computation of the welfare, there are three main effects of tax-driven migration on the optimal linear tax rate. First, tax-driven migration changes the revenue collected in equilibrium through the *revenue channel* that is captured by the *income-weighted* parameter ε. Second, tax driven migration changes the amount that can be redistributed to everyone remaining in the country through the *transfer channel* that is captured by the *population weighted* parameter ε_p. These effects are the one affecting welfare through residents' consumption, as in Equation (D.4). Third, tax-driven migration changes the total welfare through the changed number of individuals included in the welfare aggregation in equilibrium. This *size channel* affects the optimal linear tax rate through the *welfare weighted* parameter ε_w that captures the amount of welfare that can be attracted or loss due to the absolute change in the number of individuals that enter in the government sum of weighted utilities.

D.1.4 Formal Derivation of the Non Linear Optimal Tax Rates

Intensive Model

The Ralwsian government maximizes the tax revenue $R = \sum_{i=0}^{J} T_i h_i$, given that h_i is a function of $(c_i - c_{i-1}, c_{i+1} - c_i)$. The first order condition is given by the system of equation:

$$h_i = \sum_{j=0}^{I} \frac{-dh_j}{dT_i} T_j = \sum_{j=0}^{I} \frac{dh_j}{dc_i} T_j$$

As individuals can only choose between adjacent occupation, it is easy to rewrite the first order condition such that:

$$h_i = T_{i-1} \frac{\partial h_{i-1}}{\partial (c_i - c_{i-1})} - T_{i+1} \frac{\partial h_{i+1}}{\partial (c_{i+1} - c_i)} + T_i \frac{\partial h_i}{\partial (c_i - c_{i-1})} - T_i \frac{\partial h_i}{\partial (c_{i+1} - c_i)} \tag{D.7}$$

Using $\partial h_{i+1} / \partial (c_{i+1} - c_i) = -\partial h_i / \partial (c_{i+1} - c_i)$, we obtain:

$$h_i = (T_i - T_{i-1}) \frac{\partial h_i}{\partial (c_i - c_{i-1})} + (T_{i+1} - T_i) \frac{\partial h_i}{\partial (c_i - c_{i+1})}$$

Using Equation D.7 for $i = i+1...I$ and the participation elasticity $\eta_i = \partial h_i / \partial (c_i - c_{i-1}) \times (c_i - c_{i-1}) \times h_i$ we obtain:

$$\frac{T_i - T_{i-1}}{c_i - c_{i-1}} = \frac{h_i + h_{i+1} + ... + h_I}{h_i \eta_i}$$

To express the optimal tax schedule as a function of the standard labor supply elasticity e_i, I follow Saez (2002) and use $(y_i - y_{i-1})\eta_i = e_i y_i$, that yields to $\eta_i = e_i y_i / (y_i - y_{i-1})$. Using τ_i the marginal tax rate on bracket i such that $\tau_i = (T_i - T_{i-1}) / (Y_i - Y_{i-1})$, where $1 - \tau_i = c_i - c_{i-1} / Y_i - Y_{i-1}$, we obtain the formula for the optimal marginal tax rate on bracket i. As outlined by Saez (2002), in the absence of extensive margin responses to taxation, the optimal tax liabilities are always increasing with i, and negative marginal tax rates are therefore never optimal. As a result, the marginal tax rate in the first bracket is very high, and is maximal in the Rawlsian case with high redistributive taste.

Extensive Model

Let's consider now the case where individuals respond to taxation through migration. Conditional of being in the bracket i, individuals can choose to migrate from A to B if $u_i(c_i^B, y_i) \geq u_i(c_i^A, y_i)$. In that case, the fraction of individuals in a given tax bracket h_i is a function of the overall tax schedule in the bracket i T_i. Consider first the case where there are only extensive margin responses to taxation. In that case, the number of individuals in the tax bracket i is only a function of the overall tax liability T_i that determines migration decisions. The system of first order conditions follows:

$$h_i = \frac{\partial h_i}{\partial c_i} T_i \tag{D.8}$$

Making use of the migration elasticity formula:

$$\frac{T_i}{y_i - T_i} = \frac{1}{\xi_i} \tag{D.9}$$

Mixed Intensive and Extensive Model

I finally put together intensive and extensive responses to taxation. In this case, individuals in bracket i can choose adjacent occupations, but can also choose to locate abroad. The first order condition becomes:

$$h_i = (T_i - T_{i-1}) \frac{\partial h_i}{\partial (c_i - c_{i-1})} + (T_{i+1} - T_i) \frac{\partial h_i}{\partial (c_{i+1} - c_i)} + T_i \frac{\partial h_i(c_i)}{\partial (c_i)} \tag{D.10}$$

This relationship illuminates the effects of a tax reform at the extensive and intensive margins. The two first terms of Equation D.10 capture the effect of a change in the marginal rate on transitions between brackets. The last term captures the extensive margin on individuals that decide to migrate after that their overall tax liabilitie T_i has been changed. It is easy to derive the optimal top marginal tax rate from Equation D.10 :

$$\frac{T_I - T_{I-1}}{c_I - c_{I-1}} = \frac{1}{a_I e_I} \left(1 - \frac{T_I}{c_I} \xi_I \right)$$

That simplifies to the following formula, with $b_I = T(y_I)/(y_I - T(y_I))$ that captures the overall wedge of labour taxation at income level y_I and $a_I = y_I/(y_I - y_{I-1})$ the local discrete pareto parameter.

$$\frac{\tau_I}{1 - \tau_I} = \frac{1 - b_I \xi_I}{a_I e_I} \tag{D.11}$$

For any other income level, making use of the set of first order conditions, the optimal tax formula is given by:

$$\frac{\tau_i}{1 - \tau_i} = \frac{h_i(1 - b_i \xi_i) + h_{i+1}(1 - b_{i+1} \xi_{i+1}) + ... + h_I(1 - b_I \xi_I)}{a_i h_i e_i} \tag{D.12}$$

If we let one of the two elasticities e_i and ξ_i tend to zero in Equation D.12, we retrieve the optimal formula of pure extensive and intensive models. The model mixing labour supply and migration responses is similar to the pure intensive model, with weights on income groups replaced by $b_i\xi_i$, implicitly attributing more welfare weights to individuals who are more likely to respond to taxation through migration.

D.1.5 Non Linear Discrete Tax Rates with Social Marginal Welfare Weights

I consider alternatively the formal derivation of the optimal tax formulas in the case where the the government maximizes a welfare function. Individual k in the bracket i derives an utility $u^k(c_i, i)$ that is a function if his after-tax income in the bracket i c_i and of its tax bracket choice $i = 0, ..., I$. For a given tax schedule, there is a population $h_i(c_0, ..., c_I)$ of individuals who choose to be in the bracket i. I denote $k(i)$ the tax bracket choice of individual k. The government chooses the tax schedule $(T_0, ..., T_I)$ such that it maximizes the total welfare:

$$SWF = \sum_k w_k u_k$$

$$\sum h_i T_i \geq R$$

Denoting p the multiplier of the government budget constraint, the first order condition yields

$$(1 - G_i)h_i = \sum_{m=0}^{I} \frac{\partial h_m}{\partial c_i} T_i \tag{D.13}$$

With $G_i = \dfrac{1}{ph_i} \sum_{k \in bracket} w_k G'(u^k) u_c^k(c_i, k(i))$. Similarly than before, I can derive the optimal tax schedules in the federal and competition union with these alternative social welfare weights G_i. With the assumption that intensive responses only occur between adjacent occupations, the first order condition can be rewritten in the federal union as

$$(1 - G_i)h_i = (T_i - T_{i-1}) \frac{\partial h_i}{\partial(c_i - c_{i-1})} + (T_{i+1} - T_i) \frac{\partial h_i}{\partial(c_{i+1} - c_i)} \tag{D.14}$$

In the competition union, there is an additional behavioural response to taxation, and the number of individuals in each bracket h_i is affected through migration responses to taxation such that:

$$(1 - G_i)h_i = (T_i - T_{i-1}) \frac{\partial h_i}{\partial(c_i - c_{i-1})} + (T_{i+1} - T_i) \frac{\partial h_i}{\partial(c_{i+1} - c_i)} + T_i \frac{\partial h_i(c_i)}{\partial(c_i)} \tag{D.15}$$

D.2 Additional Tables and Figures

Table D.1: **Migration Elasticities of Top Ten Percent Employees**

Countries	Lower bound	Upper Bound
Belgium	.19	.27
Germany	.16	.24
France	.32	.45
Italy	.05	.07
Luxembourg	.26	.37
Poland	.12	.18
Portugal	.10	.15
Spain	.25	.34
Switzerland	.28	.41
United Kingdom	.52	.83

Notes: This Table summarizes the elasticity of the number of top ten percent employees with respect to the top net-of-tax rate estimated by **?** for the period 2009-2015 using individual-level data from the European Labour Force Survey. The empirical strategy exploits within-country variations in top marginal tax rates coming from differences in propensities to be treated by top marginal tax rates between individuals of different earnings levels. Lower bounds are computed using the 8th decile as a control group not affected by top marginal tax rates changes. Upper bounds are compited using the 5th decile as a control group not affected by top marginal tax rates changes.

Table D.2: **Empirical Earnings Distribution Calibration**

Income level (euros)	Density Weight	Cumulative Density
0	.2	.2
5,000	.05	.25
15,000	.11	.36
30,000	.14	.5
45,000	.23	.73
65,000	.17	.9
100,000	.08	.98
200,000	.02	1

Notes: This Table shows the discretized empirical earnings distribution used for the numerical simulations of the non-linear tax and transfer schedule. The data is based on the distribution of labour factor income for France provided by the World Inequality Database. I define the density at each average income level as the density of individuals whose earnings fall in the range $[y_i - (y_i - y_{i-1})/2; y_i + (y_{i+1} - y_i)/2]$.

Table D.3: **Tax-Driven Migration Only at the Top With Linear Tax Schedule**

	Scenario 1 Elasticities e=0.25 $\bar{\varepsilon}$=0.02 $\varepsilon_{D_1-D_9}$=0, $\varepsilon_{D_{10}}$=0.1		Scenario 2 Elasticities e=0.25 $\bar{\varepsilon}$=0.04 $\varepsilon_{D_1-D_9}$=0, $\varepsilon_{D_{10}}$=0.2		Scenario 3 Elasticities e=0.25 $\bar{\varepsilon}$=0.06 $\varepsilon_{D_1-D_9}$=0, $\varepsilon_{D_{10}}$=0.3		Scenario 4 Elasticities e=0.25 $\bar{\varepsilon}$=0.09 $\varepsilon_{D_1-D_9}$=0, $\varepsilon_{D_{10}}$=0.4	
I- Optimal Linear Tax Rates								
	Federal	Competition	Federal	Competition	Federal	Competition	Federal	Competition
Rawlsian	0.73	0.71	0.73	0.70	0.73	0.68	0.73	0.67
Highly Redistributive	0.65	0.63	0.65	0.61	0.65	0.59	0.65	0.57
Mod. Redistributive	0.48	0.45	0.44	0.37	0.42	0.33	0.48	0.40
II- Welfare effect of Tax Competition (%)								
	Bottom 10	Bottom 50	Bottom 10	Bottom 50	Bottom 10	Bottom 50	Bottom 10	Bottom 50
Rawlsian	-.7	-0.2	-1.7	-.3	-2.6	-.6	-3.6	-.9
Highly Redistributive	-1.7	-.7	-3.5	-1.6	-5.2	-2.4	-6.8	-3.24
Mod. Redistributive	-3.2	-1.9	-6.7	-3.7	-9.7	-5.4	-12.5	-7.0

Notes: This Table shows the welfare effects of tax competition when migration responses to taxation are concentrated at the top of the income distribution (top decile) but are zero everywhere else. This implies that $\bar{\varepsilon} = \varepsilon_{D10} - \varepsilon_{p,D10}$, as $\varepsilon_i = 0$ for every individuals who are not in the top decile. The methodology for welfare computation is described extensively in the note below Table 4.1.