# Online Appendix for International Trade Responses to Labor Market Regulations

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## Contents



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# A Additional Tables and Figures

# B Additional Institutional Details

The European posting policy is a legal framework within the European Union (EU) that regulates the temporary cross-border movement of workers. This policy allows employees from one EU member state to be temporarily posted to another member state while still being subject to the social security and labor laws of their home country. The primary goal of this directive is to facilitate the provision of services across borders while ensuring fair working conditions for posted workers.

The history of the European posting policy dates back to the 1960s when the EU began working towards creating a single market for services. Freedom to supply services is one of the four pillars of the EU single market and was thus adopted as part of the Rome Treaty. The original legal framework underwent major changes. The first Posting of Workers Directive was adopted in 1996 as a response to concerns that the differences in labor standards and wages across EU member states could lead to unfair competition and exploitation of workers in lower-wage countries. This was in the context of EU enlargement to Spain and Portugal, in particular, where wages and taxes were much lower than in the core of the EU. The primary objective of the directive was to ensure that posted workers benefit from the same core labor rights and working conditions as local workers in the host country. This was however restricted to areas such as maximum working hours, minimum rest periods, minimum paid annual leave, and minimum rates of pay.

The 2004 enlargement of the European Union (EU) marked a significant expansion of the single market. Ten new member states from Central and Eastern Europe joined the EU, which represented roughly 20% of the total EU population at the time. This enlargement brought changes in various EU rules, including those related to the posting of workers. Following the enlargement, workers from the new member states gained the right to post their workers to other EU countries under the framework of the Posting of Workers Directive. This meant that companies from the new member states could send their employees to provide services in other EU countries on a temporary basis; without having to request

Table B.1: Liberalization of posting and free movement for Eastern European Countries

| | NMS of 2004 | | NMS of 2007 | |
|---|---|---|---|---|
| Country | posting | free movement | posting | free movement |
| Belgium | 2004 | 2009 | 2007 | 2014 |
| Denmark | 2004 | 2009 | 2007 | 2009 |
| Germany | 2011 | 2011 | 2014 | 2014 |
| Ireland | 2004 | 2004 | 2007 | 2011 |
| Greece | 2004 | 2006 | 2007 | 2009 |
| Spain | 2004 | 2006 | 2007 | 2009 |
| France | 2004 | 2008 | 2007 | 2014 |
| Italy | 2004 | 2006 | 2007 | 2011 |
| Luxembourg | 2004 | 2007 | 2007 | 2014 |
| Netherlands | 2004 | 2007 | 2007 | 2014 |
| Austria | 2011 | 2011 | 2014 | 2014 |
| Portugal | 2004 | 2006 | 2007 | 2009 |
| Finland | 2004 | 2006 | 2007 | 2007 |
| Sweden | 2004 | 2004 | 2007 | 2007 |
| United Kingdom | 2004 | 2004 | 2007 | 2014 |

Notes: NMS 2004: Poland, Latvia, Lithuania, Slovakia, Slovenia, Hungary, Czech Republic, Estonia; NMS 2007: Romania, Bulgaria.

employment or work authorization in the country of destination.

The EU enlargement also triggerred the liberalization of migration (free movement of workers) for citizens of new member states. However, transitional arrangements were implemented by several existing EU member states, primarily in Western Europe. These arrangements allowed these countries to restrict the free movement of workers from the new member states for a limited period (up to seven years) after the 2004 enlargement. The idea behind these restrictions was to gradually open up their labor markets to prevent sudden disruptions in local labor markets and to mitigate potential downward pressure on wages. Those so-called "safeguard" clauses were only implemented for traditional migrants, not posted workers, with the exception of Austria and Germany that were allowed to impose transitional measures for the cross-border supply of services too. The timing of the safeguard clauses and of free movement and free posting liberalizations for new member states of 2004 and 2007 is summarized in Table B.1.

In the aftermath of the EU enlargement, a proposal for a new directive for services

was introduced. The Bolkestein Directive, formally known as the Services in the Internal Market Directive, was a proposed piece of legislation by the European Commission in 2004. The directive was named after Frits Bolkestein, the European Commissioner for Internal Market and Services at the time. The proposal aimed to address barriers that hindered the free movement of services across the EU, such as varying regulations and administrative burdens faced by service providers operating in different member states. One of the most controversial aspects of the directive was the "country of origin principle." This principle suggested that service providers should adhere to the regulations and laws of their home country, even when providing services in another EU member state. This approach was intended to simplify the regulatory environment for service providers, but critics argued that it could lead to "social dumping," where companies take advantage of lower standards in their home country to provide services in other member states. In fact, the country of origin principle in the Bolkestein proposal was opposite to the restrictions set by the 1996 directive; and were essentially reverting the minimum wage requirements for sending companies.

The Bolkestein Directive sparked significant controversy and debate across the EU. Critics argued that the country of origin principle could undermine labor standards, workers' rights, and consumer protection in some member states. They expressed concerns that service providers might establish themselves in countries with less stringent regulations to take advantage of lower costs and then provide services in other member states with higher standards. Due to the intense controversy and opposition from several EU member states, the Bolkestein Directive was significantly amended and its scope was narrowed. Essentially, the country of origin principle was removed from the final version of the directive.

The EU Regulation 883/2004, which came into effect in May 2010, introduced changes that impacted posted workers, including those in border regions. This regulation aimed to streamline and clarify the rules regarding social security coordination for individuals moving within the European Union (EU) and the European Economic Area (EEA). It sets new restrictions for payroll taxation for firms engaged in the posting program. Specifically, the authorization to maintain a posted worker under the social security system of

their employer's country can only be granted if the posted worker has been affiliated with the social security agency of the sending country for a minimum of one month prior to the posting. Furthermore, a break of two months between two posting contracts is required before the same worker can be posted to the same country. If a worker is posted to its own country of residence, the payroll taxes must also be paid in the country of destination. Furthermore, the principle whereby employees employed by a company operating across a common border of two States had to be subject to the legislation of the Member State in which the company had its registered office is changed by the new regulation (Regulation EC No. 1408/71, June 14, 1971, Article 14b(3), Official Journal of the European Communities, July 5, No. L 149, p. 2). After 2010, the Regulation No. 883/2004 indicates that the common law applies, and thus the law of the place where the employment contract is executed prevails. Furthermore, some exceptions were granted to some sectors. For instance, international transportation has traditionally been excluded from general social security regulations because of the highly mobile nature of the activity (regulation no.1072/2009). This was also true for the 2010 EU regulation: firms operating in the road transportation sector that were potentially exposed to the change in rules were granted a 10-year transitory exemption period.

The 2017 directive concerning posted workers is known as the "Directive (EU) 2017/159 of the European Parliament and of the Council of 19 December 2016 amending Directive 96/71/EC concerning the posting of workers in the framework of the provision of services." This directive amended the original 1996 Posted Workers Directive (Directive 96/71/EC) and aimed to establish more equal working conditions for posted workers compared to domestic workers in the host country. The directive was introduced against the backdrop of growing concerns about social dumping within the EU. The proposal aimed to strike a balance between facilitating the free movement of services and ensuring fair working conditions. The main proposed change was the "equal pay" principle where posted workers should be entitled to equal pay for equal work in the same location. This means that posted workers had to receive the same salary and benefits as local workers for performing the same job. In practice, this means that the destination-specific minimum legal wage requirement is replaced by the destination-specific *prevailing wage*.

Emmanuel Macron, the President of France, played a prominent role in advocating for changes to the Posted Workers Directive within the European Union (EU). His role and actions were part of France's broader efforts to address concerns related to social dumping and the rights of workers in the EU. France, under Macron's leadership, was one of the countries pushing for stricter regulations and a more comprehensive reform of the directive. The French government sought to limit the duration of postings, increase the application of host-country labor laws, and ensure equal pay for posted workers.

# C Data Appendix

This section provides additional information on the main data sources used in the main text of the paper.

## C.1 A1 forms

The main dataset used in the paper is based on A1 social security forms issued for posting of workers in the EU. Each company engaged in the posting of workers must provide a proof that their workers stay affiliated to their origin country social security system through a A1 portable document (PD A1). This form must be showed during labor inspections performed in the destination country during the posting assignment. The data on the A1 forms have been collected from European Commission (2011, 2012, 2014, 2015, 2016, 2017, 2018, 2019).

Those forms are compulsory and are issued by national social security organizations. Sometimes, the forms can be issued retroactively. The number of A1 forms must be interpreted as posting contracts, because the same posted worker can be posted several times with several A1 documents linked to each of the contracts abroad. Workers can also be sent abroad for more than a year. The A1 forms are only issued for workers posted within the EU: if a posting contract is done outside the EU, there is no A1 form issued.

The forms can be issued for workers posted to one destination country (article 12) or for workers sent to more than one destination (article 13). The issue is that for workers posted to more than one destination in a given year, the A1 dataset only gives information on the origin country, but not the multiple destination countries. Hence my baseline measure of bilateral posting flows ignores posting contracts concerning workers with more than one destination country (only focusing on article 12 postings).

However, in supplementary analysis, I allocate social security forms issued for posting contracts with more than one destination countries, to each of those destination countries. To do so, I use the composition of posting flows where information on the unique destination country is available, to allocate postings forms issued for posted workers with more than one destination. For instance, if in a given year 30% of workers posted from Poland

under article 12 (sent to only one country) are performing work in Germany, I make the assumption that 30% of workers posted from Poland under article 13 the same year (sent to more than one country) are performing work in Germany.

Although my baseline measure of bilateral posting flows is the raw number of posting forms issued at the origin-destination-year level, I adjust this measure by the duration of the contracts in some of the supplementary analysis. The European Commission also collects information on the average duration associated with the posting form by origin since 2010. As in Muñoz (2024), before 2010, or in years 2010-2019 where this information is missing, I use the average of the reported non-missing values. For a small group of countries (Bulgaria, Romania, Netherlands, Lithuania) where no information on posting duration is ever available, I use the information on similar countries. I use the average duration of posting contracts in Poland to infer this variable for Bulgaria and Romania. For Lithuania, I use Latvia. For Netherlands, I use Austria.

For a subset of six exporting countries (Poland, Luxembourg, Czech Republic, Romania, Lithuania and Hungary), the A1 forms have been collected by sector of the posting contract. The dataset has information on postings to total manufacturing (nace B to F), and construction (nace F); which allows me to observe postings from those origin countries to each destination country in the EU, each year, in the construction and manufacturing (all industry excluding construction) sector.

The posting A1 forms record the number of workers involved in the cross-border supply of services through posting; but do not provide information on the value (expenditures) associated with these contracts. Usually, standard custom datasets record the value of trade shipments better than their volume, because trade tariffs are ad-valorem taxes. However, there are no tariffs for within-EU trade, and ad-valorem trade tariffs cannot apply to services based on the WTO rules. The only reason why the EU collects information on trade in posting services is to track the *number* of posted workers in the single market, and to enforce labor regulations on those workers. The data thus come from the mandatory documents, linked to individual workers, that those employees must hold while performing work abroad under the posting scheme. While posting social security forms allow to measure posting in employment terms, there is still no accurate measure

of the monetary value associated with the cross-border service contracts. As discussed in Muñoz (2024), one solution to proxy the monetary value of posting contracts at the aggregate level is use the BOP methodology. Using this methodology, Muñoz (2024) estimates that posting flows accounted for 2% of EU GDP in 2017.

## C.2 IGSS Dataset on Luxembourgish Firms

I use an administrative matched employer-employee dataset covering all firms established in Luxembourg since 2002. The dataset is built from monthly payroll information and social security registries for all workers (including self-employed) employed by a firm located in Luxembourg. The dataset has detailed individual information on demographics, and detailed information at the job contract level (including firm and establishment IDs). A job is defined by the IGSS as the combination of a unique worker ID, a unique employer ID, and a unique date of start and end of the employment contract. I refer to number of "jobs" or "employment contracts" interchangeably. Each employment contract ("job") has a unique job identification number in the dataset. Each quarter, the dataset has information (wages, sector, etc) on each active contract ("job") in Luxembourg. The dataset is merged by the IGSS with information on posting abroad reported by Luxembourgish employers to Luxembourgish authorities. This information (variable) has been previously used by the Luxembourgish national institute to measure the number of workers posted from Luxembourg in the temporary employment agency sector (Ries and Sinner, 2012). I use the variable "jposted" defined by the IGSS as the indicator for whether the worker is posted abroad, to identify employment contracts from Luxembourg performed abroad through posting. The monthly number of employment contracts (jobs) in Luxembourg by sector and destination is computed as the sum of unique employment contracts recorded in the dataset, by status of posting abroad provided by the Luxembourgish authorities, in each month ("date") and in each sector. To compute the yearly number of jobs in each sector and by destination, I take the average of the number of jobs in each month over the year.

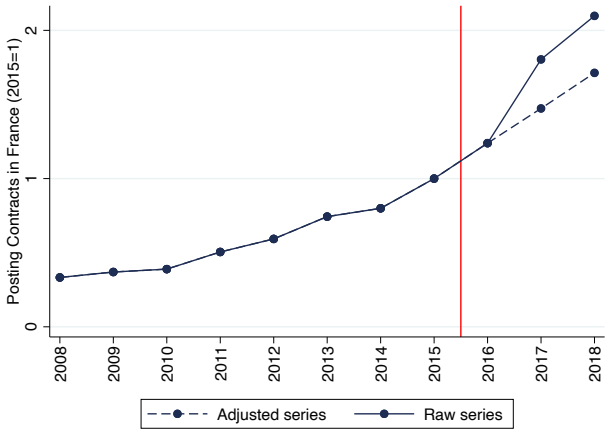
## C.3 SIPSI

France has a special notification tool covering the universe of workers posted to the French territory. Before any posting of workers to France, the foreign firm must send a DPD/SIPSI form to the local labor inspectorate. This form is a compulsory document, and a missing form implies that the posting contract is interrupted and the foreign and domestic customers are fined and potentially subject to legal lawsuits. The form has information on the identity of the sending firm located abroad and the French customer, and information on the work performed (sector of work, wages of posted workers, occupation of the posted worker). The series on these forms was collected from Direction Générale du Travail (2016, 2019).

From 2000 to 2016, the form had to be filed on paper and sent by mail to the French authorities. Since 2017, the form can be filed electronically by foreign firms. Since the way to collect the SIPSI data changed in 2017, there is a potential break in series in 2017. To be conservative and avoid over-estimating posting inflows in France since 2017, I correct the SIPSI series by using information on A1 posting forms in the year where the reporting requirements changed (2017). Although the scope of posting contracts covered by the A1 dataset and the DPD/SIPSI dataset is not exactly the same, there were no changes in reporting requirements in the A1 dataset in 2017, which should not affect the evolution of posting contracts between 2016 and 2017 in the A1 data.

To do so, I compute the ratio between the posting contracts recorded in the A1 and SIPSI dataset in 2016. I assume this ratio should have remained equal in 2017, absent the change in reporting requirements in SIPSI. This enables me to compute how much of the change in SIPSI forms in 2017 could be driven by the move to electronic filling (that should not affect reporting in the A1 dataset). I then use this constant factor to scale-down SIPSI inflows *after* 2017. Figure C.1 compares the raw series to the series adjusted for the change in reporting requirements.

Figure C.1: **Raw vs Adjusted Series in French SIPSI dataset**




Notes: This figure shows the raw SIPSI series (plain line) and the series adjusted for the change in reporting requirement in 2017, using the non-affected A1 dataset for that year. More details are provided in the text.

## C.4 Data on Labor Costs

I use data from Eurostat to measure yearly measures of gross wages and labor taxes (net of subsidies) in each EU country each year. The data comes from the Labor Cost Index dataset produced by Eurostat. It is based on firm-level surveys and administrative datasets in each EU member state. The dataset provides information on total labor costs, wages, and non-wages labor costs. The data provides information on levels of those components every four years, and the index every year, which allows to measure the yearly levels and evolution of labor costs (by each component) over the period.

The measure of non-wage components of labor costs in the LCI is based on social security contributions and other labor taxes paid by employers minus subsidies received by employers. This allows to measure the effective tax rates that nominally fall on employers. I also collect additional information on the *statutory* social security contributions rates for employers, that are collected by the OECD. This additional datasource allows to measure the headline rates that apply to firms in each country and might be more salient to employers. Figure C.2 plots the effective tax rates (from the LCI measure) against the statutory rate measure (from the OECD dataset) for the sample of EU countries that are also OECD countries. The figure shows that the correlation between those two measures

of payroll tax rates is high.

Figure C.2: **Employers' Marginal Payroll Tax Rate vs Effective Payroll Tax Rate**


Notes: This figure shows the correlation between measures of the effective payroll tax rate computed by Eurostat (social security contributions and other labor taxes paid by employers net of subsidies for employers), and the social security contribution marginal tax rate faced by employers provided by the OECD taxing wages database. Only EU countries in the OECD can be included in that figure.

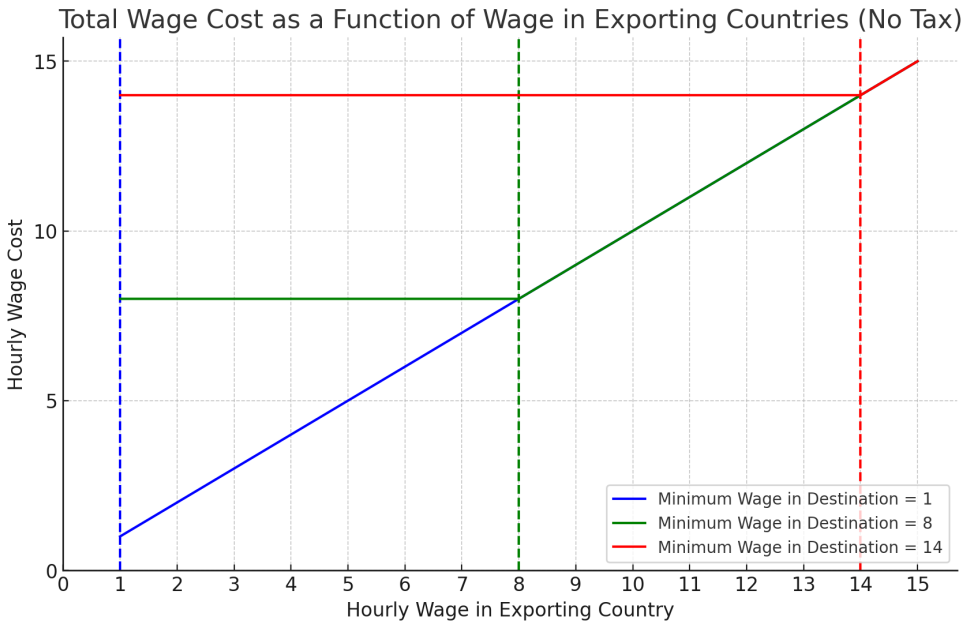
# D Gravity Estimation

## D.1 Additional Evidence on Labor Costs

In this appendix section, I provide more details on the level and variation in wage costs for posted workers in the EU, $c_{ijt}$. In Figure D.3, I show an example of how $c_{ijt}$ varies by (i) level of wage in the origin country (x-axis) and (ii) level of minimum wage in the destination country (three different series). To only show variation coming from minimum wage rules, I assume either zero payroll tax rate (Panel A) or the same payroll tax rate (at 50% rate) for all level of origin-specific wages (in the x-axis). I then plot the total hourly labor cost $c_{ijt}$ for each level of $w_{it}$ and for three potential levels of minimum wage in the destination country: 1 euro (red series), 8 euros, (green series) and 14 euros (blue series). Each of those levels correspond, respectively, to the lower minimum wage in Europe, the average minimum wage in Europe, and the highest minimum wage in Europe. Figure D.3 show how total wage cost evolves by level of wages in the exporting country for each destination country.

Figure D.3: **Variation in Labor Costs Introduced by the Posting Minimum Wage Rule**

**A. No payroll taxes in the wage cost function**




**B. Constant payroll taxes for all exporting countries**


Notes: This figure illustrates origin-specific and destination-specific variation in labor costs created by the minimum wage regulation in the posting policy. This figure plots $c_{ijt}$ for three different destination countries $j$: one with minimum wage of 1 euro, 8 euros, and 14 euros. In Panel A, I assume to payroll tax rate in the wage cost function. In Panel B, I assume a constant payroll tax rate of 50% for all level of hourly wages in the exporting country to compute the total hourly cost (y-axis) and only capture the effects of minimum wages on labor costs.

In Figure D.4, I plot the distribution of the average wage of domestic workers at French firms using posted workers (green series) and the average wage of posted workers at the same sample of firms (red series). Information on posted workers' wages are reported in the SIPSI posting forms by the foreign firms. Information on domestic workers' wages comes from a matched employer-employee dataset covering the universe of employment contracts in France (DADS Postes). More information on the matching between the SIPSI dataset on posting contracts and the French administrative dataset on workers and firms can be found in Muñoz (2024).

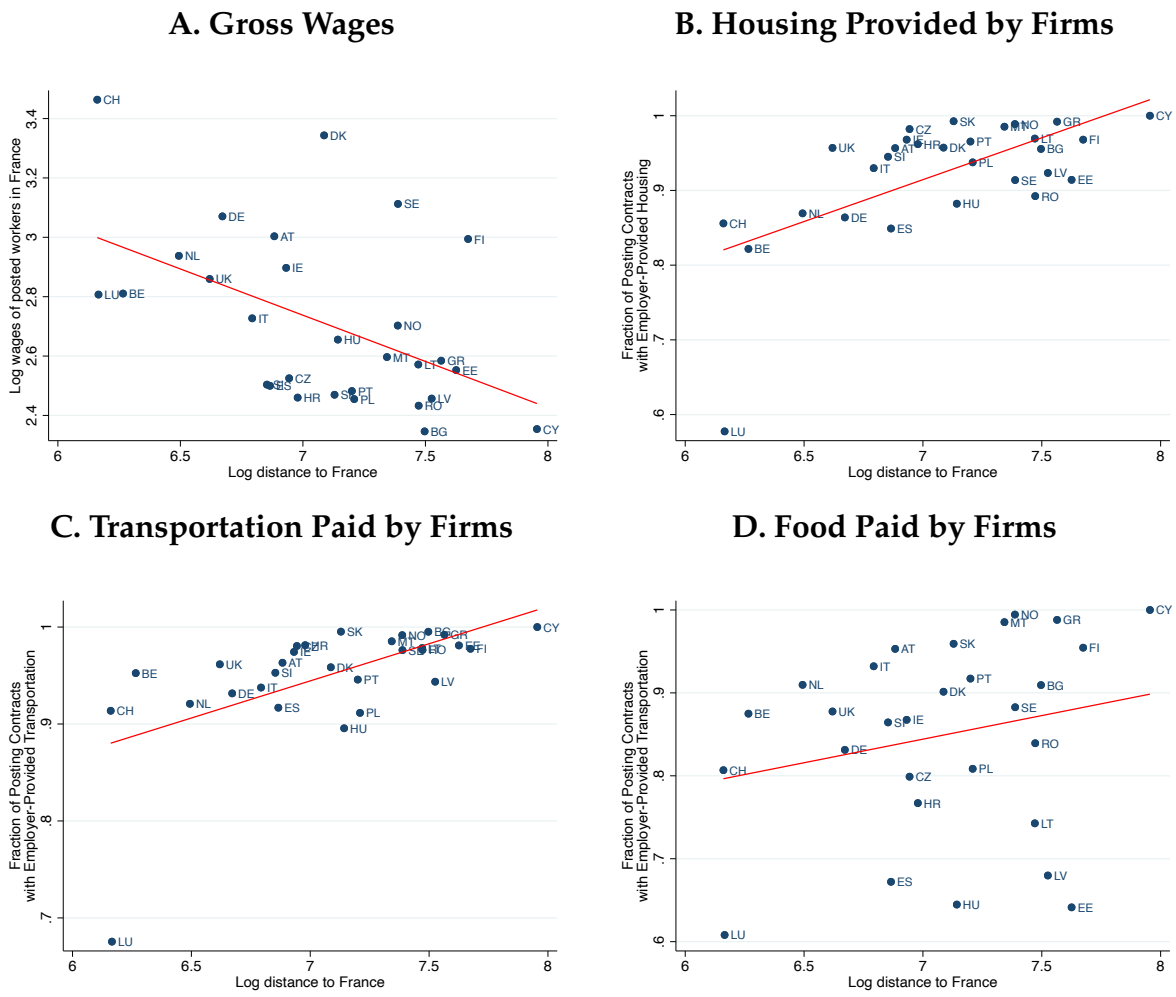
Figure D.4: **Wages Paid by Exporting and Domestic Firms in France**


Notes: This figure shows the distribution of wages paid by foreign firms to their employees posted to France (red histogram) and wages paid by French firms importing posting services to their domestic French workers (green histogram) for year 2018. Data on posted workers' wages paid by exporting firms comes from the administrative posting form SIPSI that foreign firms must file when supplying physical services in France. Data on domestic workers' wages comes from administrative matched employer-employee data in France (DADS) that I matched to French firms' ID that appear as customers (importing firms) in the SIPSI dataset.

I also use the French data environment to document the existence of compensating differentials paid by foreign firms to posted workers. The hypothesis is that firms could pay workers higher wages when they send them to a more distant location, if they need to compensate posted workers for travelling longer distances. To test this hypothesis, Figure D.5 plots measures of workers' compensation against the distance between the

destination country (France) and each origin country. Panel A focuses on gross hourly wages (which include the posting allowance to match the French minimum wage) while Panel B to D focus on in-kind benefits.

Figure D.5: **Compensating Differentials Paid by Exporting Firms in France**




Notes: This figure illustrates variations in wages for workers posted to France, based on the distance of their home country from France. Panel A shows the relationship between wages paid to workers sent from a given origin country to France and the log distance between that origin country and France. Panel B, C and D focus on non-monetary compensating differentials by looking at the fraction of posting contracts with employer-provided housing (Panel B), transportation (Panel C) and food (Panel D) for each origin country.

## D.2 Additional Graphical Evidence: Cross-Country Correlations

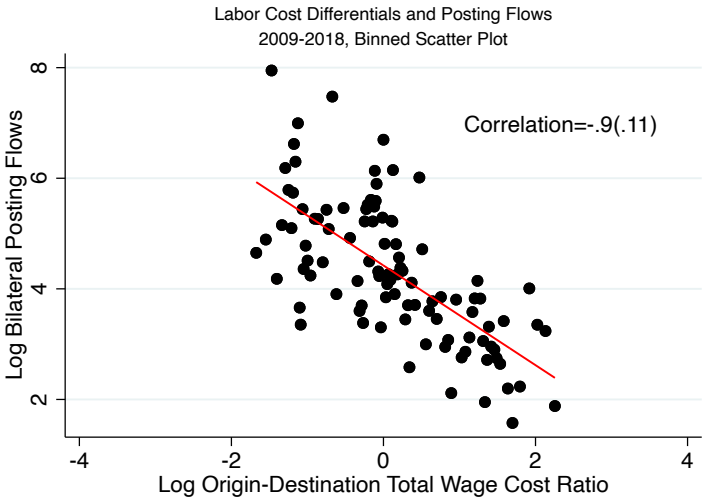
**Robustness to alternative measures of bilateral posting flows** I test the robustness of the baseline cross-country correlations between (log) labor cost differentials and (log) bilateral posting flows to alternative measurements of posting flows. In particular: (i) weighting posting flows (in the binscatter plot and the regression) by the average duration of posting contracts observed in the dataset (Figure D.6) or average wage in the origin (Figure D.7) (ii) posting flows measured in euros-expenditures by multiplying the number of posting contracts at the origin-destination-year level by information on duration of the posting contract at the origin-year level and and wage costs for this country-pair-year cell (Figure D.8) (iii) using log-odd ratios $\log S_{ijt}/S_{jjt}$ as the alternative outcome variable in the binscatter plot and regression (Figure D.9)

**Robustness to measures of labor cost differentials** I also test the sensitivity of the cross-sectional relationship by varying measures of labor cost differentials. In particular, I repeat the baseline exercise (i) using the ratio of payroll tax rates $\log(\tau_{it}/\tau_{jt})$ instead of the ratio of total wage cost $\log(c_{ijt}/c_{jjt})$ on the x-axis (Figure D.10) (ii) controlling for the wage differential $\log(w_{it}/w_{jt})$ on top of the log tax rate differential (Figure D.11). I also investigate the cross-sectional relationship between posting flows and unemployment differentials, that proxy differences in labor market conditions between origin and destination countries in Figure D.12.

**Bilateral trade in other types of activities** I also investigate these correlations for other types of services and goods that vary in their intensity in low-skill labor. When focusing on all trade in goods between EU countries in Panel B of Figure 3, I use data on bilateral trade flows from Head and Mayer (2014). Next, I use data on trade in financial services, that are services that are not low-skill labor intensive. The data on financial services come from the OECD Balanced International Trade in Services. I also use data on trade in footwear and apparel from the BACI database which is produced by CEPII. I reproduce the baseline cross-country correlations but using log bilateral trade flows (in values) for those two types of activities. The results are displayed in Panel A of Figure D.13 for trade

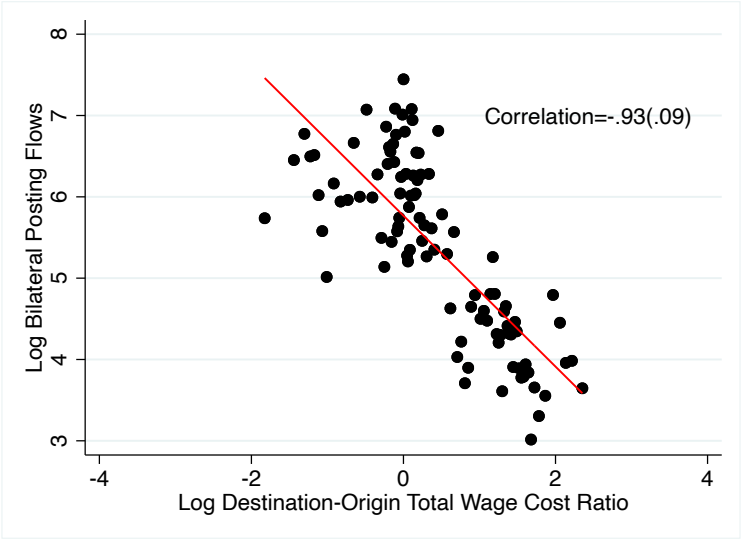
in financial services, and in Panel B for trade in footwear and apparel.

Figure D.6: **Weighting Posting Flows by Duration of Posting Contracts**



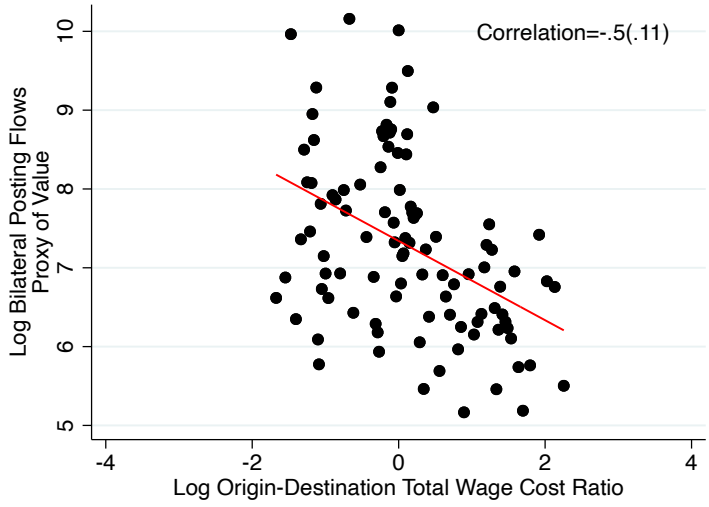

Notes: This figure shows the correlation between log of bilateral posting flows and log of total wage cost differentials, weighting observations by the average duration of posting assignments.

Figure D.7: **Weighting Posting Flows by Wages in the Origin Country**



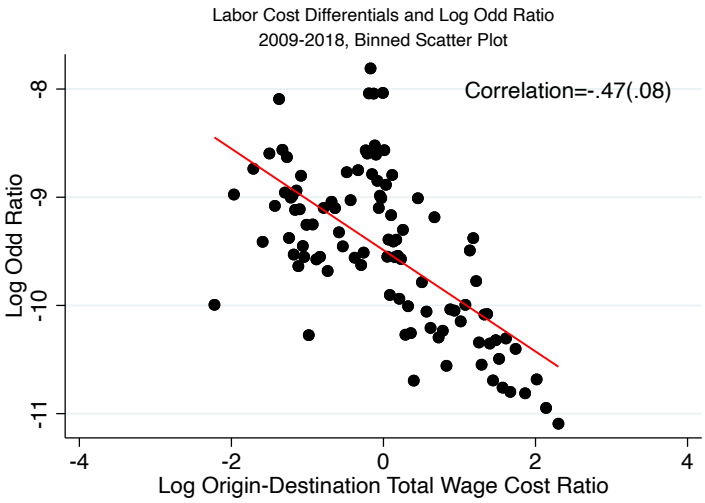

Notes: This figure shows the baseline correlation between log of bilateral posting flows and log of total wage cost differentials, weighting bilateral posting flows by the average wage in the exporting country.

Figure D.8: **Using Expenditures-Equivalent Measures of Bilateral Posting Flows**



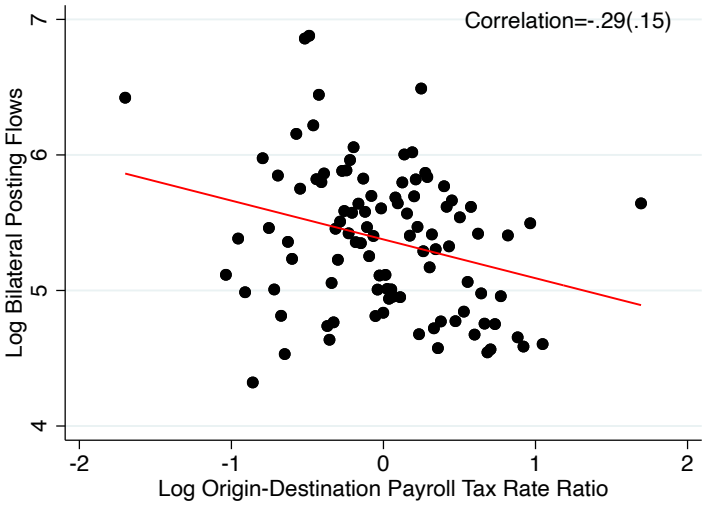

Notes: This figure shows the baseline correlation between log of bilateral posting flows and log of total wage cost differentials, replacing the number of workers sent from one country to the other by average duration of posting contracts and the average labor cost paid to those workers (which also appears in the x-axis measure).

Figure D.9: **Log-Odd Ratios**



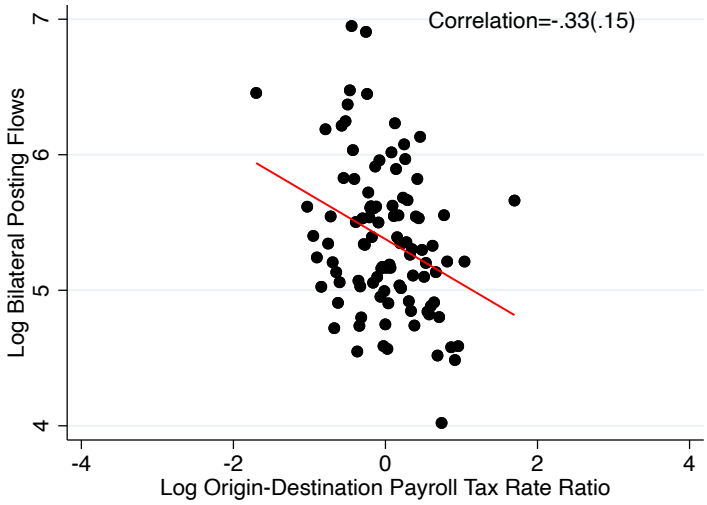

Notes: This figure shows the correlation between log of odd ratios ($\log(S_{ijt})/S_{jjt})$) and log of the labor cost differential between country $i$ and country $j$.

Figure D.10: **Payroll Tax Rates Differentials**



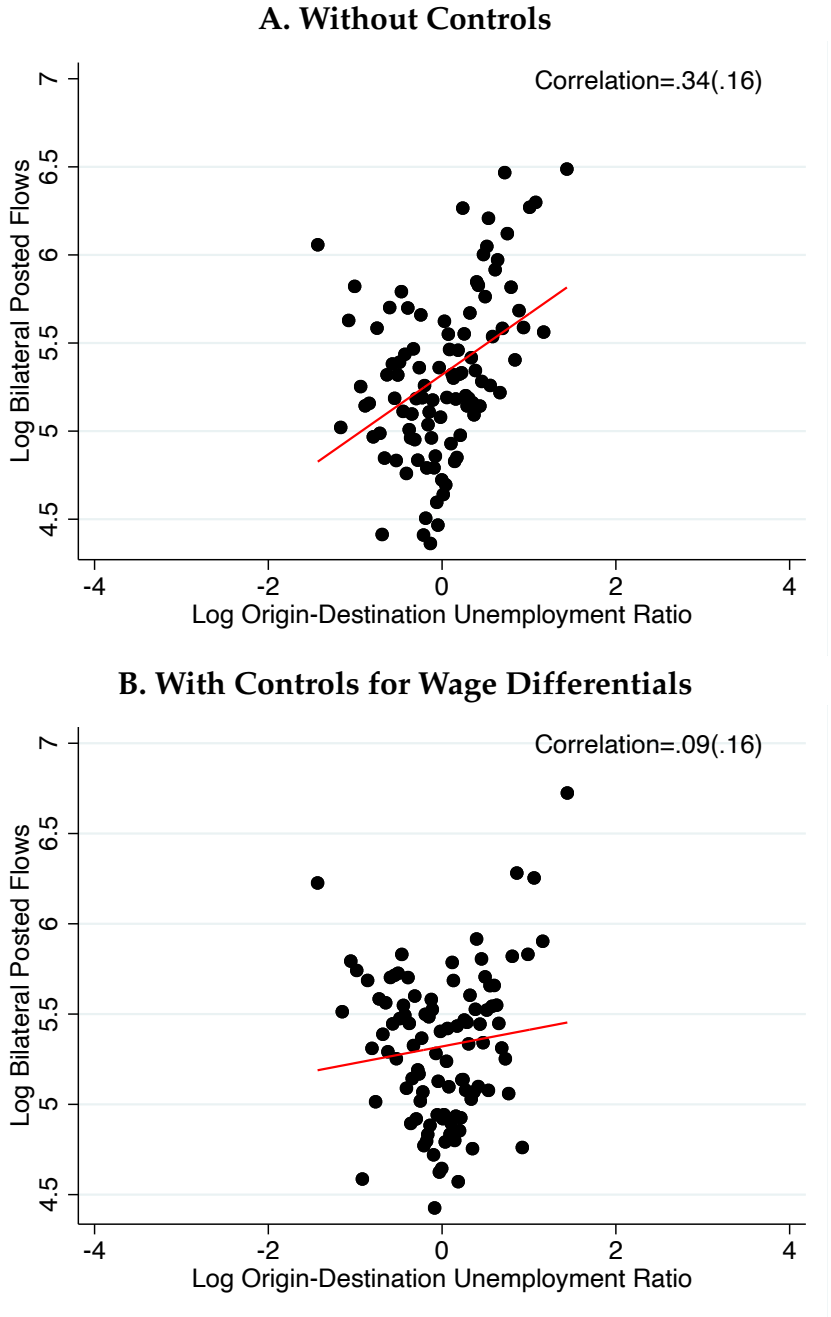

Notes: This figure shows the correlation between log of bilateral posting flows and log of the payroll tax rate ratio as a measure of differences in labor cost between two countries.

Figure D.11: **Payroll Taxes Differentials Controlling for Wage Differences**




Notes: This figure shows the correlation between log of bilateral posting flows and log of the payroll tax burden ratio as a measure of differences in labor cost between two countries, after controlling for the log of the average wage ratio between the two countries.

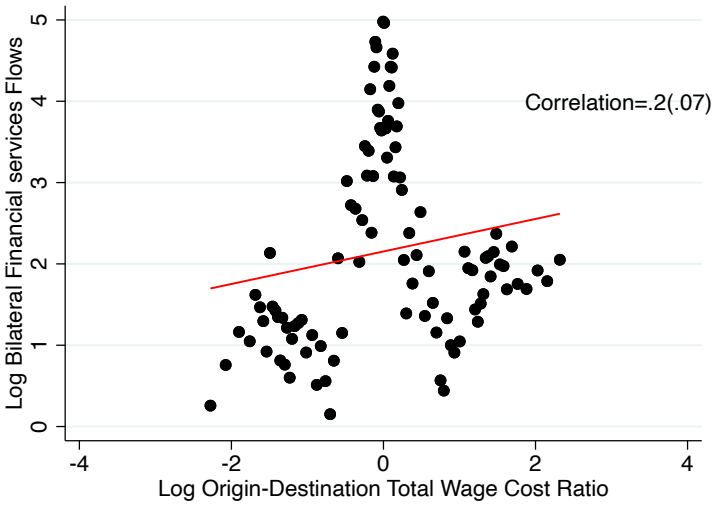
Figure D.12: **Bilateral Posting Flows and Unemployment Differentials**



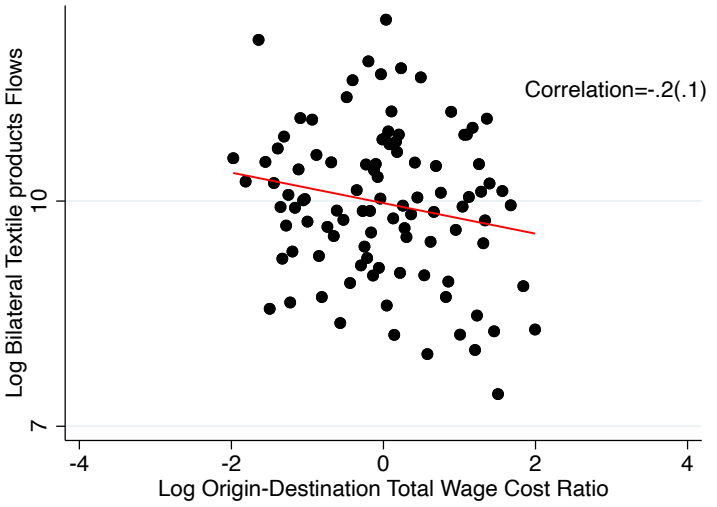

Notes: This figure shows the relationship between bilateral posting flows (y-axis) and the difference between the origin-destination unemployment rate (x-axis). The top panel shows the unconditional relationship, while the bottom panel controls for the origin-destination wage ratio.

Figure D.13: **Trade in more or less low skill-labor intensive services and goods**

**A. Bilateral Trade in Financial Services**




**B. Bilateral Trade in Footwear**




Notes: This figure shows the correlation between labor cost differentials and log of bilateral trade in financial services (Panel A) or bilateral trade in footwear and apparel (Panel B).

## D.3 Robustness of Gravity Estimation

I also provide additional evidence on the robustness of the baseline gravity estimation. I use alternative inference procedures, using clustered standard errors at the pair-level in Column 1 of Table D.2 and twoway clustered standard errors at the destination-year and the origin-year level in Column 2 of Table D.2. In column 3, I also restrict the estimation sample to the euro zone only. I also allocate flows of posted workers with more than one destination country observed for each exporting country each year, to each destination country. To do so, I use the origin-destination specific bilateral posting shares observed for "regular" (e.g., with only one destination country) posting flows the same year. For instance, if 20% of regular posting contracts from Poland are going to Germany in a given year, I allocate 20% of posting contracts from Poland with more than one destination country, to Germany the same year. The results using this alternative measure are showed in Column 4 of Table D.2.

I also present additional gravity estimates, using alternative measures for average wages when building measures of $c_{ijt}$. This is to test if the estimates of $\theta$ are sensitive to the assumption that nationwide average wages are a good proxy of the wages paid to posted workers when building measures of $c_{ijt}$. I collect data on NACE 2 sectoral wages and employers' non-wage labor costs from Eurostat published for all EU countries.[1] The agricultural sector is not covered by this dataset. Using alternative (sectoral) measures of $w_{it}$ and $w_{it}\tau_{it}$, I re-construct bilateral measures of employers' wage costs $c_{ijt}$ for each origin-destination-year cell. Table D.3 uses measures of $c_{ijt}$ built using average (with equal weights) wages and payroll taxes in three sectors where posting is prevalent: construction, manufacturing and services of the business economy. Table D.4 uses average wages and payroll taxes measured in the construction sector only to construct $c_{ijt}$, which is the number one sector relying on posting services.

Finally, Table D.5 uses a measure of $c_{ijt}$ where the posting allowance is incorporated in the tax base of the origin country, that is $c_{ijt} = \mathbb{1}_{(w_{it} \geq \underline{w_{jt}})}[\, w_{it}(1+\tau_{it})] + \mathbb{1}_{(w_{it} < \underline{w_{jt}})}[\, \underline{w_{jt}}(1+\tau_{it})]$ . This means that the log wage cost is additively separable in i-specific and j-specific terms when the posting allowance is positive (e.g., if $w_{it} < \underline{w_{jt}}$).

[1] Some countries, such as Denmark, do not publish this data.

Table D.2: **Additional Gravity Specifications**

| VARIABLES | (1) MPPML | (2) MPPML | (3) MPPML | (4) MPPML |
|---|---|---|---|---|
| $\log(c_{ijt})$ | -1.189*** | -1.189*** | -1.202*** | -1.118*** |
| | (0.346) | (0.238) | (0.245) | (0.210) |
| Observations | 5,532 | 5,532 | 4,731 | 5,486 |
| Pair FE | Yes | Yes | Yes | Yes |
| Destination × Year FE | Yes | Yes | Yes | Yes |
| Origin × Year FE | Yes | Yes | Yes | Yes |
| Internal Flows | No | No | No | No |
| Alternative Specification | Pair Clustering - | Destination × Year Origin × Year | Excluding outside Eurozone | Multi-Country Flows |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: *p<0.10, **p<0.05, ***p<0.01. This table shows additional specifications for the baseline gravity estimation presented in the main text. The specification is the same as in column (5) of Table 1 but with different inference procedures in column (1)-(2) and excluding countries outside the euro zone in Column (3). Column (4) allocates flows of posted workers with more than one destination country observed for each exporting country each year, to each destination country using bilateral posting shares observed for regular posting flows the same year.

Table D.3: **Elasticity Estimates using Average Wages in Exposed Sectors**

| VARIABLES | (1) OLS | (2) OLS | (3) PPML | (4) MPPML | (5) MPPML | (6) MPPML |
|---|---|---|---|---|---|---|
| $\log(c_{ijt})$ | -0.990*** | -1.043*** | -1.169*** | -1.862*** | -1.015*** | -1.062*** |
| | (0.200) | (0.212) | (0.119) | (0.313) | (0.188) | (0.200) |
| Observations | 5,447 | 5,209 | 5,441 | 5,441 | 5,441 | 5,672 |
| R-squared | 0.958 | 0.930 | | | | |
| Pair FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Destination × Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Origin × Year FE | No | No | No | No | Yes | Yes |
| Internal Flows | Yes | No | No | No | No | Yes |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: This table shows additional specifications for the baseline gravity estimation presented in the main text. The specification is the same as in Table 1 but with a measure of $c_{ijt}$ that uses information on average wages and payroll taxes measured in sectors exposed to posting trade (construction, manufacturing and business services).

Table D.4: **Elasticity Estimates using Average Wages in Construction Sector**

| VARIABLES | (1) OLS | (2) OLS | (3) PPML | (4) MPPML | (5) MPPML | (6) MPPML |
|---|---|---|---|---|---|---|
| $\log(c_{ijt})$ | -1.250*** | -1.317*** | -1.059*** | -1.688*** | -0.877*** | -0.815*** |
| | (0.193) | (0.205) | (0.115) | (0.279) | (0.162) | (0.181) |
| Observations | 5,230 | 5,002 | 5,205 | 5,205 | 5,205 | 5,426 |
| R-squared | 0.958 | 0.929 | | | | |
| Pair FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Destination × Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Origin × Year FE | No | No | No | No | Yes | Yes |
| Internal Flows | Yes | No | No | No | No | Yes |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: This table shows additional specifications for the baseline gravity estimation presented in the main text. The specification is the same as in Table 1 but with a measure of $c_{ijt}$ that uses information on average wages and payroll taxes measured in the construction services, which is the sector most exposed to posting trade.

Table D.5: **Robustness to Including the Posting Allowance in the Tax Base**

| VARIABLES | (1) OLS | (2) OLS | (3) PPML | (4) MPPML | (5) MPPML | (6) MPPML |
|---|---|---|---|---|---|---|
| $\log(c_{ijt})$ | -0.714*** | -0.748*** | -1.019*** | -2.007*** | -1.012*** | -1.054*** |
| | (0.189) | (0.199) | (0.122) | (0.382) | (0.176) | (0.190) |
| Observations | 5,539 | 5,291 | 5,532 | 5,532 | 5,532 | 5,767 |
| R-squared | 0.958 | 0.930 | | | | |
| Pair FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Destination × Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Origin × Year FE | No | No | No | No | Yes | Yes |
| Internal Flows | Yes | No | No | No | No | Yes |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: This table shows additional specifications for the baseline gravity estimation presented in the main text. The specification is the same as in Table 1 but with a measure of $c_{ijt}$ that incorporates the posting allowance ($\underline{w_{jt}} - w_{it}$) in the tax base of the origin country.

## D.4 Effects on Immigration and Trade in Goods

This section tests whether variations in bilateral labor costs for posted workers affect other margins of trade in factors within the EU: trade in goods and bilateral migration flows. In Table D.6, I use data on bilateral trade in goods (measured in dollar values) from Head and Mayer (2014) and Head and Mayer (2021) for the period 2009-2017. This dataset has no information on internal trade flows for goods.[2] I repeat the specifications showed in Table 1, but using log bilateral trade flows (in expenditures and not volume) as the outcome variable. The regressor $\log(c_{ijt})$ is the same as in Table 1 and is the posting-specific wage cost that accounts for the specific tax and minimum wage rules set by the posting program.

In Table D.7, I repeat the baseline gravity estimation, using bilateral migration flows as an alternative outcome. I use a dataset from Eurostat that records the stock of foreign citizen in each EU country each year by country of citizenship. Yearly changes in the stock of citizen from country $i$ residing in country $j$ at time $t$ thus proxy for bilateral immigration flows. Note that this dataset does not cover posted workers since it only covers the population of foreign residents (which does not include posted workers). The regressor $\log(c_{ijt})$ is the same as in Table 1 and is the posting-specific wage cost that accounts for the specific tax and minimum wage rules set by the posting program.

## D.5 Comparing Posting and Migration Flows in the EU

To estimate the net effects of changes in posting-specific labor costs on trade in factors within the EU, one would need to compare the absolute magnitudes of responses in both posting and standard migration flows. However, this comparison is challenging at the EU level for several reasons. First, although the A1 social security forms provide a credible measure of the evolution in the number of posting contracts each year, they lack information on the exact number of hours worked per contract. Without these details, it is difficult to convert the A1 forms into a yearly total of hours worked by posted workers,

[2]This means that the trade shares for goods are only computed using trade flows for $i \neq j$, while the trade shares for posting flows $\lambda_{ijt}$ include domestic flows $S_{jjt}$ in the denominator, see the main text for more details.

Table D.6: **Elasticity of Trade in Goods With Respect to Posting-Specific Labor Costs**

| VARIABLES | (1) OLS | (2) PPML | (3) MPPML | (4) MPPML |
|---|---|---|---|---|
| $\log(c_{ijt})$ | 0.525*** | 0.414*** | 0.351*** | 0.0675 |
| | (0.0730) | (0.0493) | (0.0595) | (0.0921) |
| Observations | 5,400 | 5,400 | 5,400 | 5,400 |
| R-squared | 0.991 | | | |
| Pair FE | Yes | Yes | Yes | Yes |
| Destination × Year FE | Yes | Yes | Yes | Yes |
| Origin × Year FE | No | No | No | Yes |
| Internal Flows | No | No | No | No |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: This table repeats the estimation strategy presented in Table 1 and described in the main text, replacing the outcome variable by bilateral trade in goods from Head and Mayer (2014). Robust standard errors clustered at destination-year level are in parentheses.

in particular because posting contracts may last more or less than a year. Second, the dataset used to estimate immigration responses in Table D.7 records the yearly stock of working-age migrants from a given EU origin in a given EU destination. This measure is not directly comparable to cross-border migration flowsâwhich are unavailable by origin-destination-year for the entire EU. [3]. Relying on migration stocks requires assuming that yearly changes in the population of standard migrants (aged 15â64) are driven exclusively by net migration, ignoring other demographic factors such as aging and mortality. Furthermore, the dataset measures the number of working-age foreign workers rather than the number of employed foreign workers, whereas posted workers, by definition, are employed abroad. This means that the dataset does not precisely measure the yearly total of hours worked by new immigrants, nor of existing foreign-born workers in a given EU country.

Using more comparable measures of native, foreign, and posted worker employment using a different French dataset, Muñoz (2024) documents the substitution between posted

[3]It would be possible to estimate flows using the EU-LFS dataset but this survey only covers 0.3% of the EU population.

Table D.7: **Elasticity of Migration With Respect to Posting-Specific Labor Costs**

| VARIABLES | (1) OLS | (2) PPML | (3) MPPML | (4) MPPML |
|---|---|---|---|---|
| $\log(c_{ijt})$ | 0.300*** | 0.705*** | 0.605*** | 0.278 |
| | (0.110) | (0.118) | (0.116) | (0.172) |
| Observations | 4,218 | 4,230 | 4,230 | 4,230 |
| R-squared | 0.995 | | | |
| Pair FE | Yes | Yes | Yes | Yes |
| Destination × Year FE | Yes | Yes | Yes | Yes |
| Origin × Year FE | No | No | No | Yes |
| Internal Flows | No | No | No | No |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: This table repeats the estimation strategy presented in Table 1 and described in the main text, replacing the outcome variable by number of working-age individuals from country $i$ in country $j$ at time $t$. This outcome variable is logged when running the equation using the OLS estimator. The outcome is in levels when using PPLM, and in migration shares (e.g., number of individuals from $i$ to $j$ / total number of individuals in $j$) when using the MPPML estimator. Robust standard errors clustered at destination-year level are in parentheses.

workers and standard migrants in the destination labor market. The findings suggest that a 1% increase in the share of posted workers in total employment of a French region is associated with a 0.7% decrease in the employment share of EU and non EU foreign workers in that region. However, this substitution effect from migration to posting services appears to be driven by the adjustment of employment of the *existing* foreign workforce, in particular from non-EU origins. Muñoz (2024) also documents that standard migration flows from new member states to France did not decrease after that posting flows to France expanded due to the liberalization of the posting policy.

# E Additional Evidence on Payroll Taxes: Belgian Tax Shift

**The reform** I study a large exogenous payroll tax cut reform in one of the main importing countries, Belgium. This reform has two advantages. First, it was really large. Employers' social security contributions rate on all employees hired in Belgium was decreased from 33% to 25% starting at the beginning of 2016.[4] Second, the reform was revenue neutral which restricts potential aggregate effects through changes in tax revenues. The payroll tax cut was paid for by increases in VAT, excise duties and dividend taxation.[5]

**Effects of the Reform on Trade in Posting Services** To the extent that the payroll tax cut in Belgium decreased labor costs for Belgian firms, the model predicts that Belgium should import less posting services after the reform. To test this prediction, I rely on a difference-in-differences setting where I compare labor services imported by Belgium to labor services imported by a similar country, before and after the reform. I use France as my main control group, because of its notification tool (similar to the one used in Belgium) that allows me to observe aggregate imports of posting services in both countries. France and Belgium also share a border and are amongst the largest importers of posting services, which makes them plausibly comparable.

Figure E.14 shows graphically the differences-in-difference setting provided by the reform. It plots the number of posting contracts from 2010 to 2018 (normalized to one in 2015 just before the reform implementation) imported by Belgium (treatment) and by neighboring France (control). The dashed line (and right axis) shows the evolution of employers' statutory payroll tax rates in Belgium and France, before and after the reform. Payroll taxes decreased by roughly 30% in Belgium between 2015 and 2018, but remained stable in France during the same period.[6] Belgium and France were importing posting services at a similar trend before 2015, suggesting that postings to France provides a credible com-

[4]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.

[5]The goal of this reform was to shift the burden of taxation from labor to other sources, as in a "fiscal devaluation" (Farhi et al., 2014).

[6]In 2013, France introduced a targeted tax credit (CICE) for some firms employing workers paid less than 2.5 times the minimum wage (Carbonnier et al., 2022). Tax credits and targeted measures do not appear in the measure of statutory payroll tax rates. This could lead me to underestimate the effects of the Belgian tax shift. I will show alternative estimates using alternative control countries in the robustness analysis.

parable counterfactual for postings to Belgium. Imports of posting services started to slow down in Belgium immediately after the reform, while postings to France kept growing at a similar rate than before 2015. The figure suggests that the payroll tax cut significantly slowed down imports of services in Belgium relative to France.

To get an estimate that is comparable to the baseline elasticity from the gravity estimation, I compute the corresponding elasticity from a 2SLS regression of the form:

$$\log S_{jt} = \alpha - \theta \log c_{jt} + \gamma_t + \gamma_j + \varepsilon_{jt}, \tag{1}$$

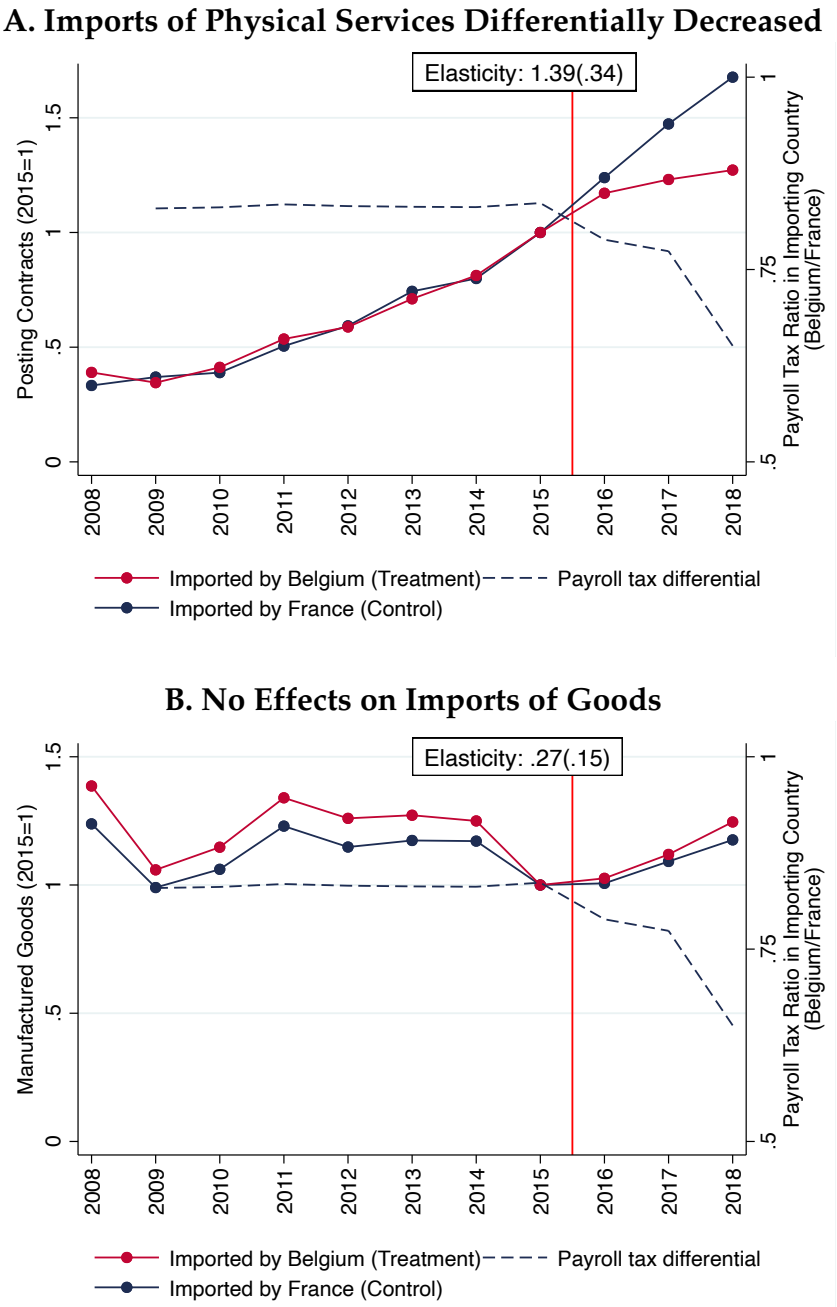
where $S_{jt} = \sum_i S_{ijt}$ is total imports of posting services in destination $j$ and year $y$ and $j = \{\text{Belgium}, \text{France}\}$. To leverage exogenous variation in labor costs, I use the reform interaction $\mathbb{1} \cdot (j = \text{Belgium}) \times \mathbb{1} \cdot (t \geq 2015)$ as an instrument for $c_{jt}$. The identification assumption is that postings to France and Belgium should be affected by similar time-varying factors, while only Belgian demand for posting services should be exposed to the Belgian tax cut. Pre-reform trends allow me to test this assumption. Any Belgium-year specific shock that would be correlated to the tax reform and would cause postings to Belgium to evolve differently than postings to France is a threat to the identification of $-\theta$. These confounding factors were filtered-out by destination-year fixed effects $\gamma_{jt}$ in the preferred gravity specification. The implied estimated elasticity of posting flows with respect to (instrumented) total labor cost ($c_{jt}$) is 3.7(.7). This accounts for endogeneous changes in equilibrium gross wages $w_{jt}$, although Figure E.15 shows no distinguishable wage responses to the reform.

The gravity model predicts that the payroll tax cut should boost exports of posting services from Belgium $S_{it} = \sum_j S_{ijt}$ by decreasing wage costs for Belgian firms $c_{it}$. Figure E.16 confirms that the reform had large (but opposite sign) effects on exports of labor services from Belgium. Belgium started to export more posting services relative to France after the payroll tax cut in Belgium. The elasticity of posting exports with respect to the Belgian labor tax rate is -2.8(1.3). High-wage countries like Belgium and France however export little volume of labor services, leading to noisier measures of posting flows and visually less convincing pre-trends.

Panel B of Figure E.14 also investigates the effects of the same reform on trade in goods,

which are expected to be less sensitive to taxes on labor because goods production is more capital intensive. I find no discernable response to the change in Belgian payroll taxes when focusing on trade in manufacturing goods. Overall, Figure E.14 can be viewed as the quasi-experimental equivalent of the cross-sectional evidence presented in Figure 3. An exogenous shock in labor costs has a larger causal effects on trade in physical (labor-intensive) services than in manufacturing (less labor intensive) goods.

Figure E.14: **Effect of Cutting Payroll Taxes in Belgium on Imports**




Notes: This figure shows the effects of a budget-neutral 2015 reform that decreased Belgian employers' social security contributions by 8 percentage points, on imports of labor services (Panel A) and imports of manufacturing goods (Panel B). The dashed line (and left y-axis) shows the evolution of the payroll tax rate ratio in Belgium (treatment) versus France (control), before and after the reform. The figure shows how imports of posting services in Belgium (treated, red series) evolved compared to imports of posting services in France (control, blue series) before and after the policy-induced change in domestic labor cost in Belgium. All series are normalized to one the year before the implementation of the labor tax cut. The elasticity reported in the figure is computed with respect to the change in the statutory payroll tax rate using the 2SLS procedure described in the main text.

**Robustness** The tax shift was not targeted at firms operating in specific sectors. One worry is that the reform, even if revenue neutral, generated general equilibrium effects that affect the demand for foreign services through other channels than the effects on labor cost differentials. Figure E.17 repeats the analysis using imports as a fraction of GDP as an outcome variable, which should capture simultaneous changes in Belgium aggregate demand relative to France. Posting imports (measured in percent of GDP) follow parallel trends until 2015 and start to diverge right after that Belgium lowered its payroll taxes.

Another worry is that the effects are driven by using France as a control group. Figure E.19 shows robustness leveraging the EU-wide dataset and the Abadie et al. (2010a) method to build an alternative control group using all available importing countries, excluding France. The effects are qualitatively similar, the elasticity is 0.6(.22) instead of 1.45(.32) in the baseline analysis.[7]

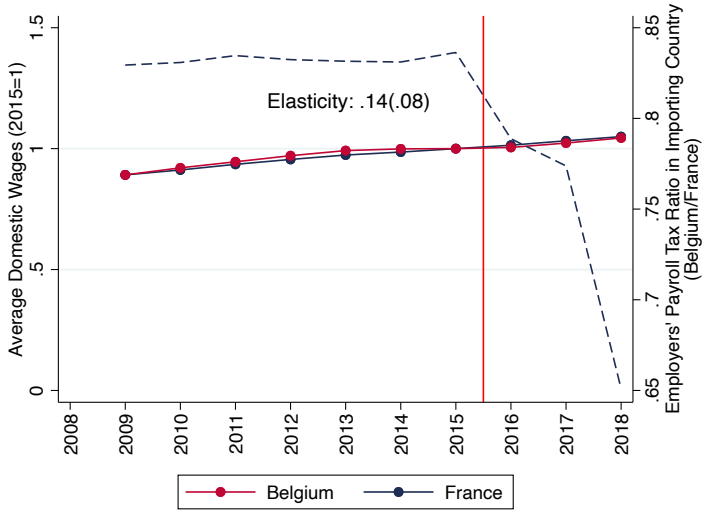
Overall, the graphical evidence in this section shows substantial and long-lasting trade responses to the Belgian payroll tax cut, both for exports and imports of posting services. While the difference-in-differences setting created by the policy lends credibility to the identifying assumption, I cannot control for destination-specific shocks that are contemporaneous to the nationwide payroll tax cut. In the main text, I use within-country reforms (in both exporting and importing countries) that alleviate those identification threats.

## E.1 Additional Graphical Evidence

This subsection presents additional evidence on the effects of the Belgian tax shift reform. It shows effects of this payroll tax cut on average wages in Belgium and the control neighboring country (France) in Figure E.15. It also investigates the effects of the payroll tax cut on *exports* of posting services from Belgium (Figure E.16), adjusting imports of posting services by GDP (Figure E.17) and showing the raw series that potentially over-estimate the expansion of posting services in France and therefore over-estimate the differential decline posting imports in Belgium (Figure E.18).

[7] Figure E.18 shows the raw series non adjusted for the change in reporting in SIPSI, leading to a larger estimated elasticity of 2.53(.75).

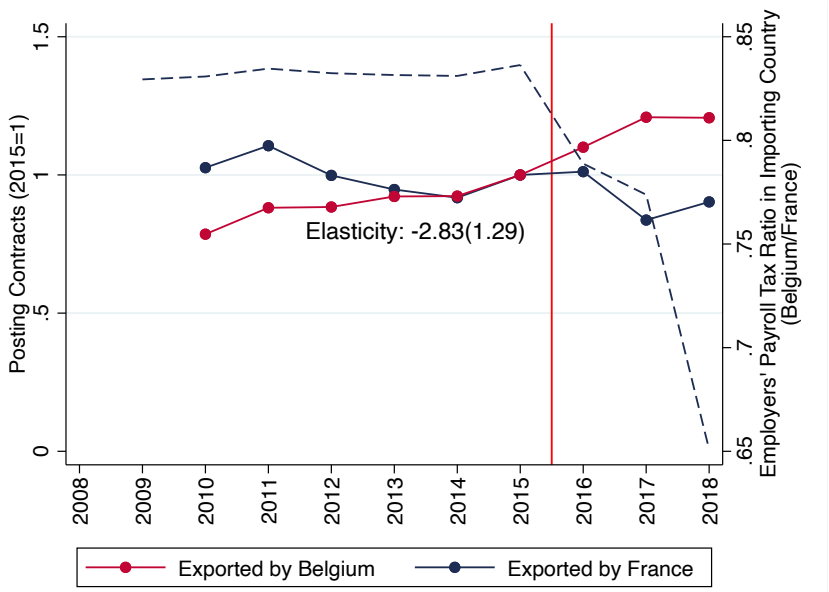
Figure E.15: **Effect of a Payroll Tax Cut in Belgium on Gross Wages**



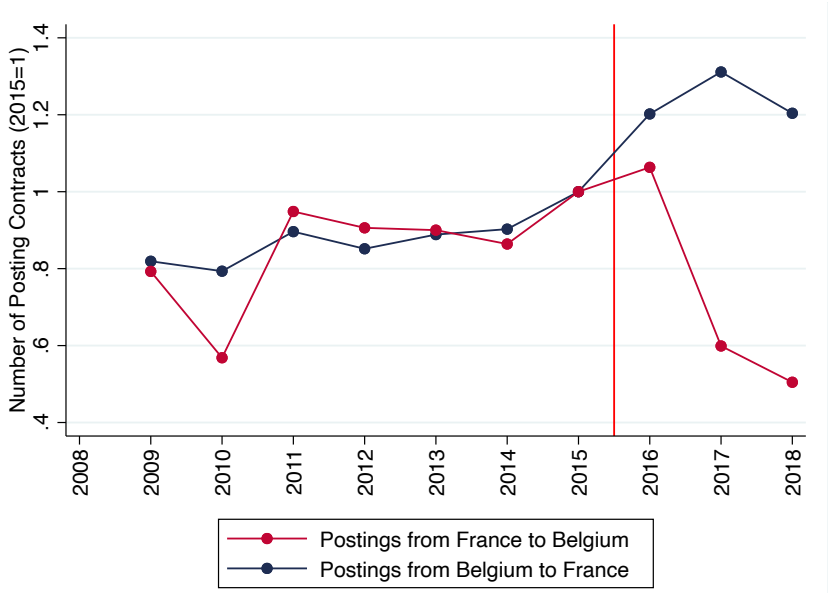

Notes: This Figure repeats the difference-in-differences analysis of the Belgian tax shift reform, using average gross wages instead of posting flows as the outcome variable, in Belgium and France.

Figure E.16: **Effect of a Payroll Tax Cut in Belgium on Exports of Posting Services**

**A. Exports of Posting Services from Belgium vs France**

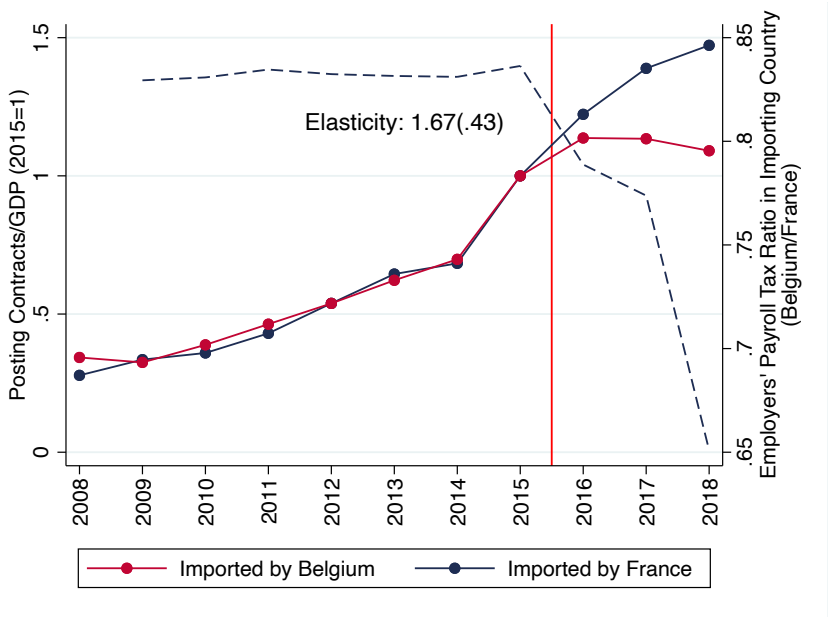



**B. Bilateral Trade in Posting Services Between France and Belgium**



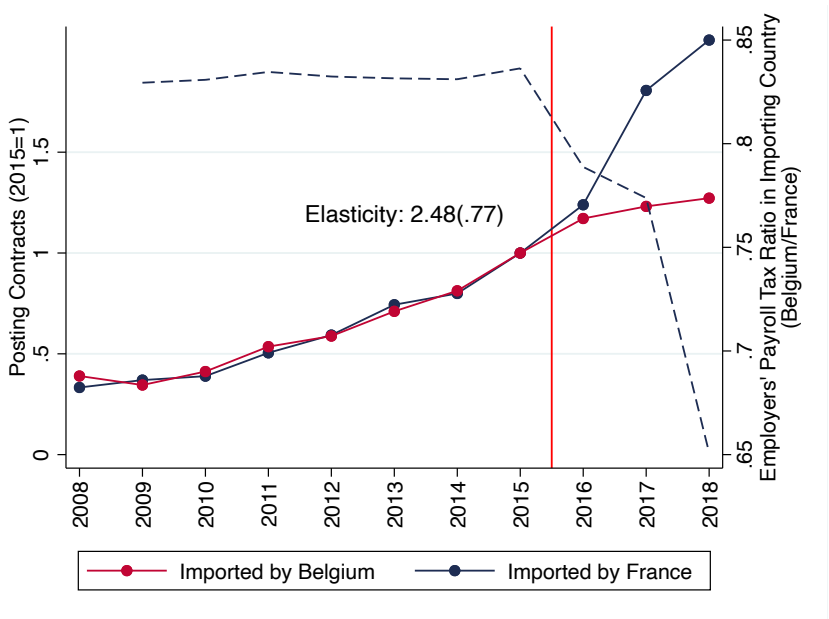

Notes: This Figure repeats the difference-in-differences analysis of the Belgian tax shift reform, using exports of posting services from Belgium and France as an alternative outcome variable. Exports of posting services are measured from the EU-wide dataset available from 2009 to 2018 as described in the text. The elasticity in Panel A is computed from a 2SLS regression as described in the text.

Figure E.17: **Adjusting for Changes in Aggregate Demand After the Reform**




Notes: This Figure repeats the difference-in-differences analysis of the Belgian tax shift reform, using posting imports divided by GDP, in Belgium and France.

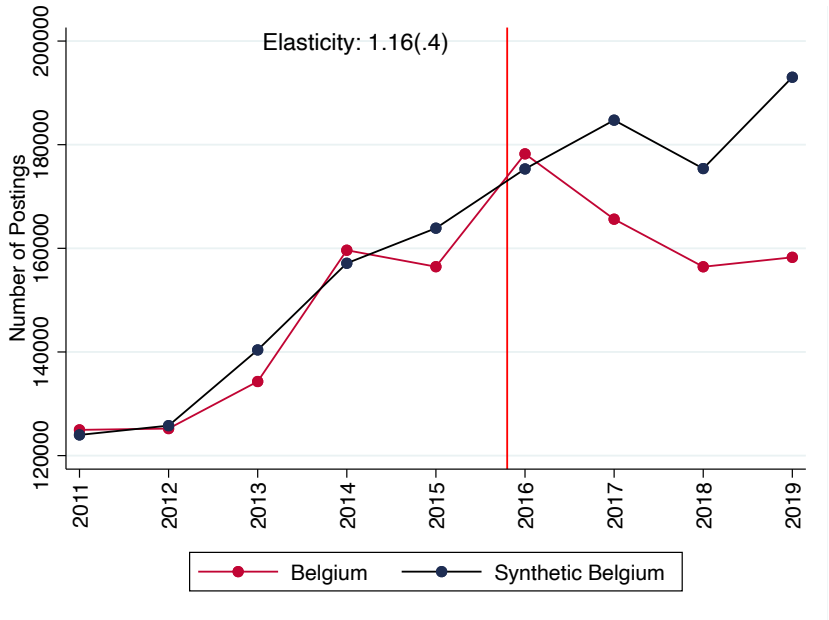
Figure E.18: **Effect of a Payroll Tax Cut in Belgium on Posting Imports: Raw Series**




Notes: This Figure plots raw series non corrected for a potential break in series in 2017 due to a change in reporting system in France. More details can be found in the main text when describing the datasets.

## E.2 Synthetic Control Analysis

Figure E.19: **Effect of a Payroll Tax Cut in Belgium: Synthetic Control Method**



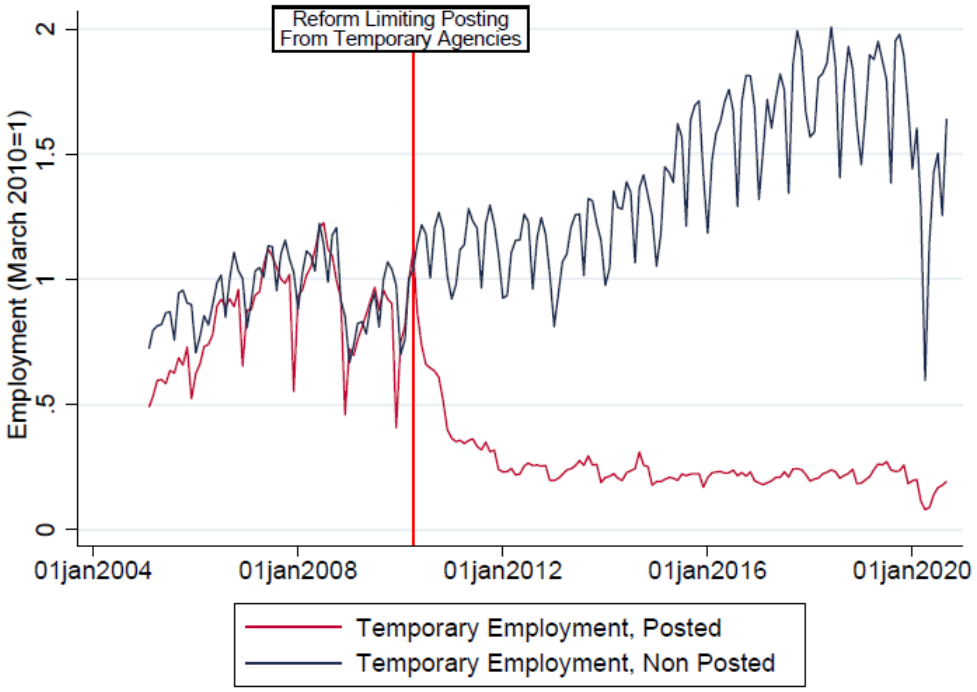

Notes: This Figure repeats the difference-in-differences analysis of the Belgian tax shift reform, using a synthetic control country (Abadie et al., 2010b) instead. The elasticity reported in the figure is computed with respect to the change in payroll tax rate.

# F Destination-Based Taxation: Additional Evidence

## F.1 Additional Graphical Evidence on the 2010 Reform

In this subsection, I provide additional graphical evidence on the effects of the 2010 EU regulation on exports of labor services from Luxembourg, using more disaggregated data. The series, plotted in Figure F.20 enable to see if exports of temporary employment agency services dropped in the month that followed the implementation of the new destination-based tax regulation.

Figure F.20: **Exposed Luxembourgish Firms Did Not Anticipate the Tax Shock**




Notes: This figure shows the effects of a EU regulation that imposed destination-based payroll taxation on temporary employment agencies located in border regions posting workers in neighboring countries. The reform is depicted by the vertical red line in May 2010. The figure shows monthly employment stock in Luxembourgish placement agencies for workers posted abroad (red series, treatment) and workers supplying services domestically (blue series, control), before and after the reform.

## F.2 Effects of the 2010 Reform on French Imports of Posting Services

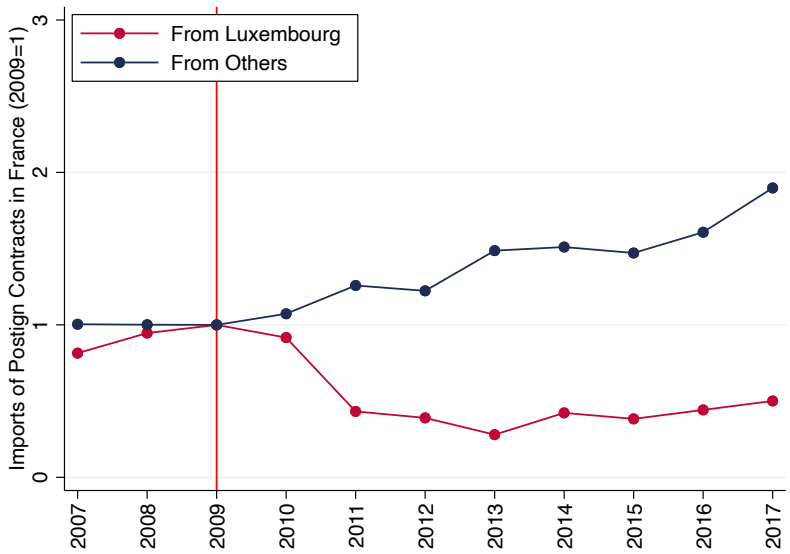
In this section, I investigate the effects of the 2010 destination-based taxation reform on imports of posting services in an exposed destination country. Comparing imports of posting services by origin country *within* a given destination allows me to filter out any unobserved foreign demand shock that could drive the decline in Luxembourgish exports in the treated sector. Figure F.21 shows this alternative comparison in France, the main importer of Luxembourgish labor services before 2010. France imported 71% of all posting services exported by Luxembourg in 2009. I use data on the EU posting forms to measure imports of posting services in France by origin country over time.

Panel A shows that France cut by half its imports of all posting services from Luxembourg after the reform. This confirms than when foreign services become more expensive because of payroll taxation, foreign firms become less competitive and sell less of their services. Panel B shows that at the same time, French imports sourced from other countries did not deviate from their pre-2010 trends. This confirms that the drop in postings from Luxembourg is driven by the changes in taxes rather than negative shocks affecting the demand of French customers.

Figure F.21: **Effect of the 2010 Reform on French Imports**

**A. French Imports of Posting Services from Luxembourg Dropped**


**B. French Imports from Other Countries**



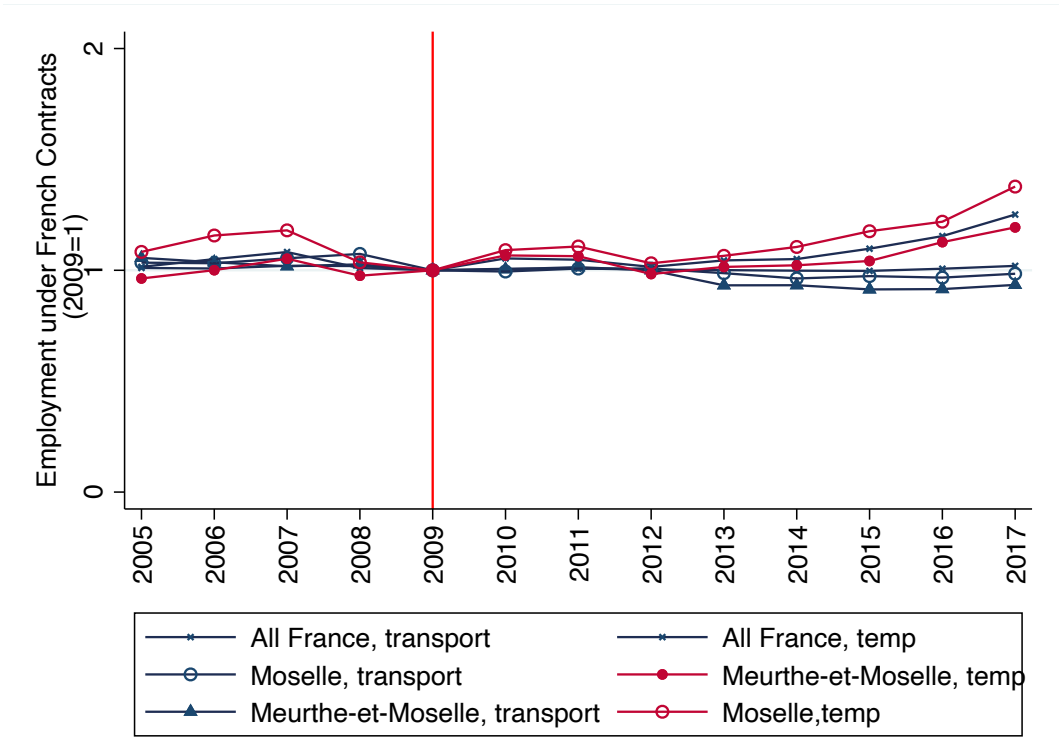

Notes: This Figure shows the effects of the 2010 reform described in the main text on imports of posting services from Luxembourg in France. Panel A shows raw number of imported posting contracts operated by Luxembourgish companies in France. Panel B shows imports of posting contracts in France from Luxembourg (treated, red series) and all other countries but Luxembourg (blue series, control). Series in the bottom panel are all normalized to one in the pre-reform year (2009).

## F.3 Effect of the 2010 Reform on French Domestic Employment

I finally exploit a dataset on French employment by sector to study whether the drop in imports of posting services in the more exposed sectors translated into an increase in the employment of workers in the same sector under French employment contracts. Like in Figure I.29, I use a dataset on French sectoral employment: if posted workers from Luxembourg are then hired directly by French firms, their employment appears in the French employment statistics.

I plot in Figure F.22 the evolution of French employment in the treated and control sector around the reform. The red series show employment in the treated sector and in departments that share a border with Luxembourg which are more directly affected by the reform and associated "re-labelling" responses. There is no noticeable uptick in the employment of temporary agency workers under French contracts in immediate response to the 2010 reform. Although employment in the temporary employment agency sector slightly increases relative to the road transportation sector after 2013 in all regions, this rise does not seem to be caused by the reform, as there are no break in trends in 2010. The same pattern observed across France's entire labor market suggests that these changes are primarily driven by broader trends affecting temporary agency employment from 2013 onward, rather than the reform itself.

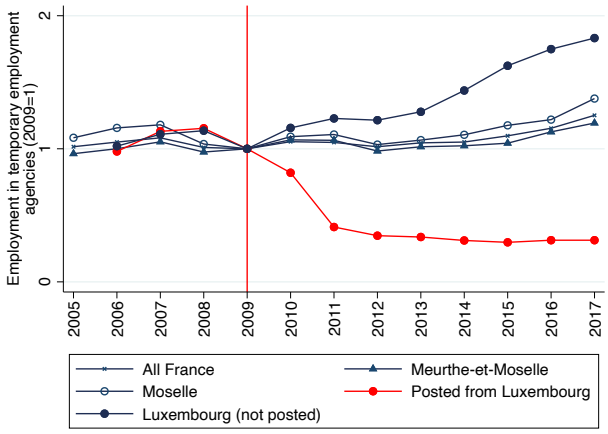
Figure F.22: **Effect of the Reform on 2010 French Employment by Sector and Region**



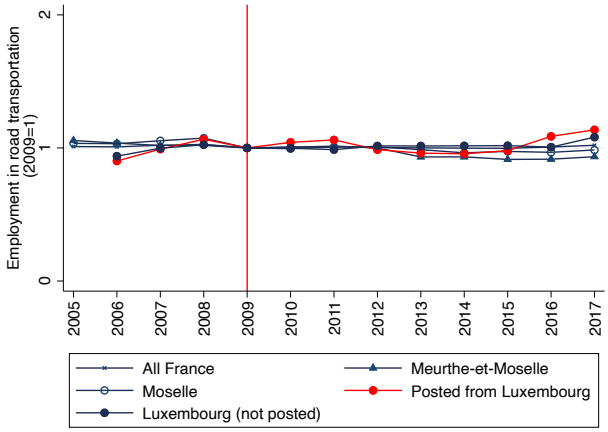

Notes: This figure shows the evolution of domestic employment in France in the temporary employment agency sector and the road transportation sector in departements that share a border with Luxembourg (Moselle and Meurthe-et-Moselle) and in all France. The series that should be affected by re-labelling after the 2010 reform are in red; the series that should not be directly affected are in blue. Data on employment under French contracts come from INSEE.

Figure F.23: **Effect of the 2010 EU Regulation on Employment in France and Luxembourg**

**A. Employment in Temporary Employment Agencies**




**B. Employment in Road Transportation**




Notes: This figure shows the evolution of employment in France and Luxembourg, in the temporary employment agency sector (panel A) and road transportation sector (panel B). French series come from INSEE and record employment under French contracts by sector and departements of work; Meurthe-et-Moselle and Moselle are French departements that share a border with Luxembourg. Luxembourgish series come from the IGSS micro data and record employment under Luxembourgish contracts by sector and whether workers are posted abroad (red line) or supplying services in Luxembourg (blue line, round markers). All series are normalized to one in 2009, the year before the reform.

# G The Change in Payroll Tax Exemption Duration Threshold

Exploiting variation in tax rates across countries over time and within-country over time, I showed that labor tax rates shape trade competitiveness in labor-intensive services. In

this section, I focus on variation in payroll taxes caused by regulatory duration thresholds. For the same importing-exporting-firm cell, payroll taxes vary from origin-based to destination-based if the contract lasts more than a given duration. In the presence of trade responses to labor taxes, the duration of posting contracts should exhibit discontinuities around this discontinuity in tax rates, especially for services supplied in high-tax countries.

To test this assumption, I use the exhaustive micro dataset on all workers posted to France from 2017 to 2020. For each posting contract, I observe the exact duration of the service contract performed in France each year. Furthermore, France has the highest level of payroll tax rates in the EU (Figure 1, Panel C), meaning that all exporting firms, regardless of their origin country, should have incentives to avoid paying French taxes by not crossing the duration threshold. In practice, we expect to see an excess of posting contracts that stop exactly at the duration threshold to avoid the corresponding change in labor costs.

Figure G.24, Panel A, plots the distribution of posting contracts' duration in 2017. The distribution exhibits a spike just below the 24-month threshold (depicted by the vertical red line), which corresponds to the tax-related threshold for that year (e.g the "notch" in the average payroll tax rate faced by foreign firms).[8] One issue in interpreting this "bunching" as behavioral responses to discontinuities in tax rates is that distortions around local thresholds can be driven by other unobserved factors rather than the underlying discontinuity in tax incentives itself (Kleven, 2016). For instance, the 24-month threshold could coincide with a reference point for exporting firms and workers. In that case, the observed distortion is not driven by the change in average tax rate at the threshold, but by other confounding discontinuities located at the same threshold.

To rule-out this explanation, I exploit the fact that the threshold was moved to 18 months by a new EU regulation introduced in July 2020.[9] The EU posting trade program

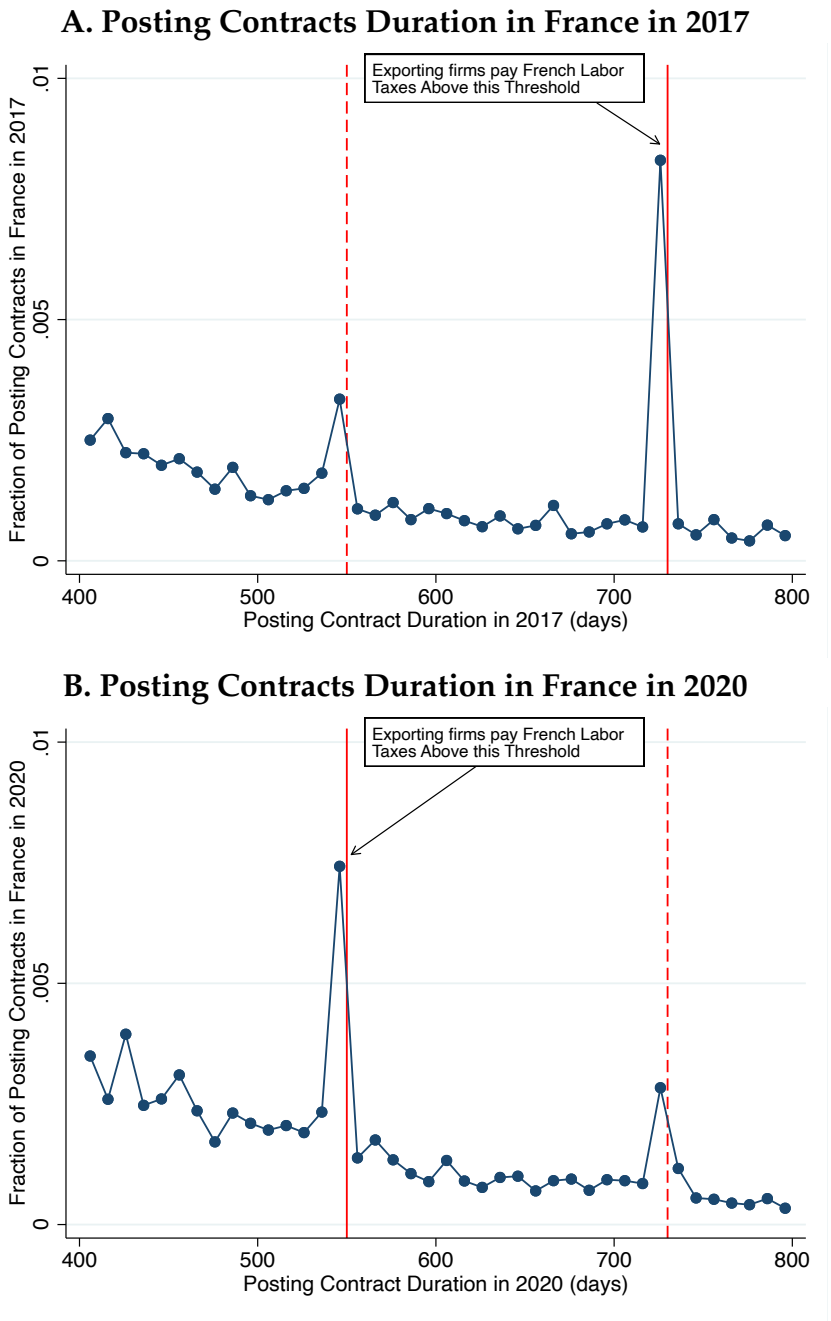
[8]Only 10% of posting contracts last more than a year. Thus, this threshold does not affect most firms. There is also some bunching around the 18-month threshold in 2017, but the excess mass is much smaller than what is observed at the tax threshold. Small bunching at the 18-month threshold in 2017 can be attributed to the fact that "1.5 years" (or three semesters) is likely a key reference point for posting contracts.

[9]The new regulatory threshold was first introduced in a EU Directive voted in 2018, but member states had until July 2020 to adopt it. I thus focus on 2017 as the "pre-reform" distribution, since in that year the 18-month threshold was not associated with any change in perceived or actual regulation.

thus not only creates sharp discontinuities in the level of payroll tax rates applying to exporting firms with different duration of activity abroad, it also creates exogenous changes in those discontinuities over time. I can thus verify that bunching follows the change in the tax threshold. Panel B plots the distribution of contracts' length starting in 2020. A substantial bunching in the distribution appears at the new regulatory threshold (vertical red line) while the excess mass at the old threshold (vertical dotted red line) decreases substantially. Note that bunching at the 24-month threshold does not disappear completely, which suggests that some of it was driven by bunching at reference points or at round numbers. But the major shift in the excess mass towards the new tax threshold confirms that the prime driver of bunching responses at the duration threshold comes from the corresponding notch in payroll tax rates.

Overall, the bunching evidence presented in Figure G.24 confirms the presence of substantial responses to payroll tax differentials which is consistent with the previous difference-in-differences analysis. This is also evidence that payroll tax differentials do not only shape the quantity of posting services traded across countries (the extensive margin) but also the length of those services (the intensive margin).

Figure G.24: **Exporting Firms Bunch to Avoid French Labor Taxes**




Notes: This figure shows the distribution of the duration of posting contracts (grouped by bins of 10 days) performed in France, the country with the highest payroll tax rate in the EU. The vertical red line in each figure depicts the regulatory thresholds for destination-based taxation set by the EU. This threshold was 24 months since 2010 and was moved to 18 months in 2020, with a transitory period between 2018 and 2019. When exporting firms operate in France with contracts of one more day than the regulatory threshold, they become subject to the French payroll tax rate (for the full posting contract). The threshold thus creates a notch in the average labor tax rate faced by exporting firms supplying physical services in France.

# H Posting Reponses to Origin-Based Taxation: Additional Evidence from the Slovenian Posted Bonus

I additionally 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.[10] 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 H.25). According to the theoretical framework, this payroll tax cut should increase trade 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.

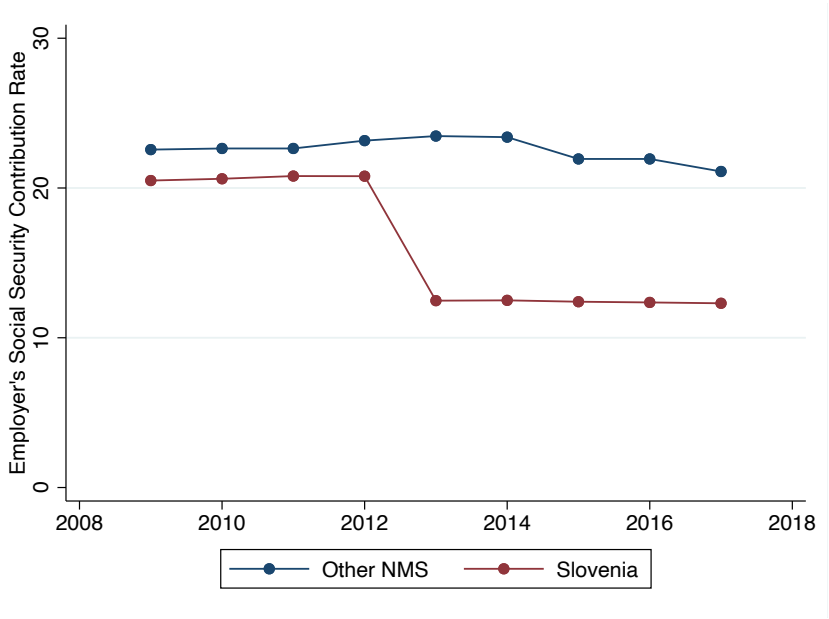
Figure H.26 shows graphically the differences-in-difference setting provided by the reform. The top panel plots the number of posted workers from 2008 to 2017 (normalized to one in 2012 just before the reform implementation) sent by Slovenia (treatment) and by other NMS (control) to Austria, the main 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

[10]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.

term $\Phi_{jt}$ that should affect demand for workers posted from Slovenia and other NMS 2004 countries similarly. The figure shows 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 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.[11] Next, Panel B 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 elasticity with respect to payroll tax rate in the origin country of -2.3(.71).

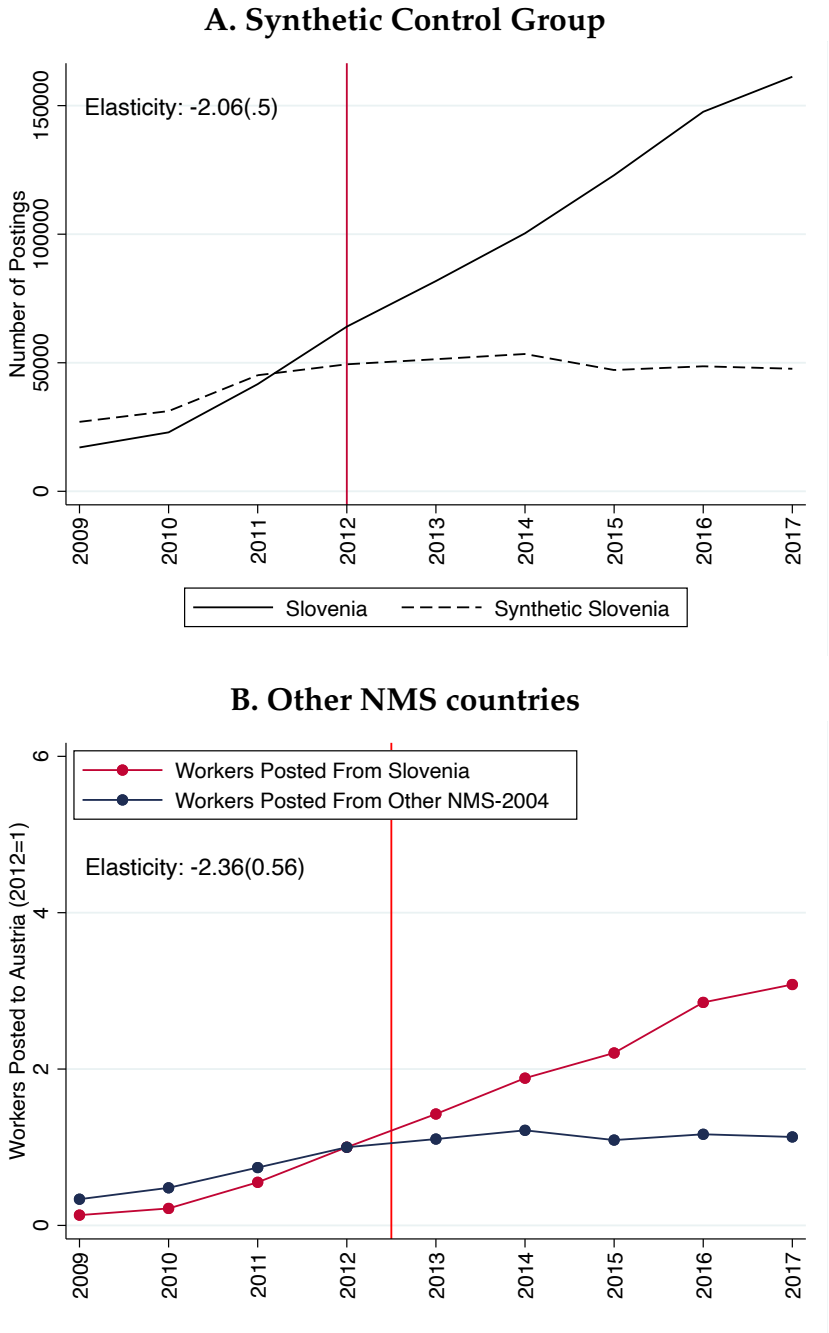
[11]The corresponding reduced form estimates for the elasticity of posting flows with respect to origin-specific non-wage labor cost component are respectively -1.77 (.23), -1.70(.24) and -1.3(.18), while the elasticity with respect to total wage cost is larger, with a point estimate of -5.5(.72).

Figure H.25: **Slovenian Posted Bonus and Payroll Tax Rate**




Notes: This 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 H.26: **Trade Responses to Slovenian Posted Bonus**

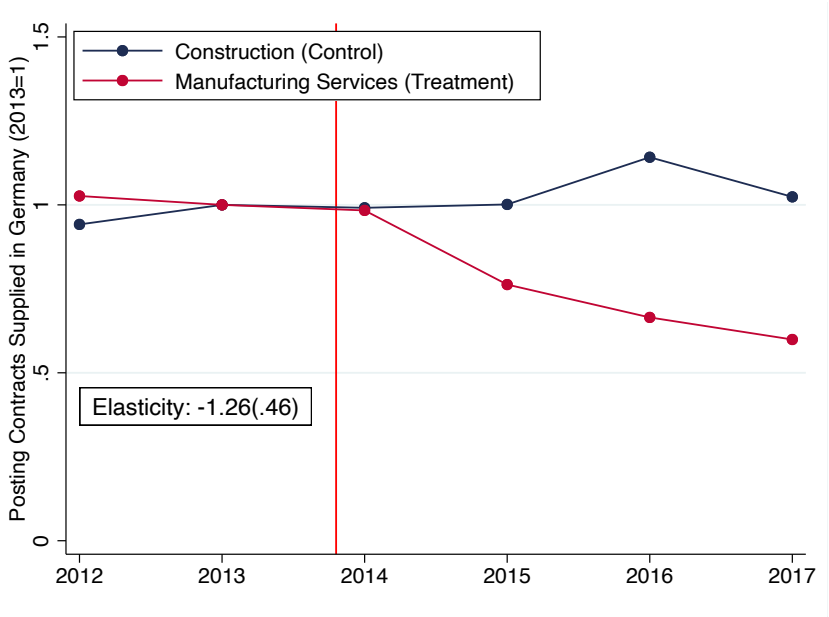



Notes: This Figure shows the effects of a payroll tax cut for workers posted from Slovenia, on exports of posting services from Slovenia.

# I The German Minimum Wage Reform: Additional Evidence

## I.1 Additional Graphical Evidence

Figure I.27: **Effects of the German Reforms Excluding Romania**




Notes: This Figure shows the effects of the German 2014-2015 reforms excluding exports from Romania to Germany. The elasticity is estimated from the 2SLS specification described in the main text.

## I.2 Effects on German Employment and Immigration to Germany

To study the effects of the German minimum wage reform, I use the Occupational Panel for Germany. This dataset is built from the IAB Employment History, which is a matched employer-employee dataset covering all employees subject to social security in Germany. The dataset excludes "marginal part-time employees, and further groups like apprentices, trainees and working students."[12] It is important to note that posted workers are not included in this dataset, since by definition posted workers are formally employed in their country of origin and do not have German employment contracts. On the other

[12]See documentation https://www.degruyter.com/document/doi/10.1515/jbnst-2022-0053/html.

hand, standard immigrants do appear in this dataset, since they are hired like natives through German employment contracts.

The dataset covers the years 2012-2018. It contains information aggregated at the occupation-level. The information includes number of employees, average wages, share of foreigners and share of workers employed through temporary employment agencies. The occupation definition differentiates (1) unskilled/semiskilled workers, (2) skilled workers, (3) specialists and (4) experts. The dataset is aggregated at the occupation-skill-year level. One drawback of this aggregation is that we can observe, for each occupation-skill level the share of foreigners, and the share of temporary agency workers, but we cannot observe the share of foreign temporary agency workers in a given occupation-skill-year cell. Another limitation is that this dataset only has employment and wage information for occupations defined at the 3-digit level. To measure German economic outcomes in the meat processing sector, I must focus on the 292 occupation code, which includes processing of all food and tobacco products.

I run the following equation:

$$\begin{aligned} \log(Y_{st}) = \alpha + \gamma \cdot \mathbb{1}(s = \text{food processing}) \times \mathbb{1} \cdot (t \geq 2014) + \\ \mathbb{1} \cdot (s = \text{food processing}) + \mathbb{1} \cdot (t \geq 2014) + u_{st} \end{aligned} \tag{2}$$

The interaction coefficient $\gamma$ captures the differential evolution of domestic economic outcomes in food processing relative to construction, after the reform relative to the pre-reform period.

I start by showing in Figure I.28 that wages of workers employed in Germany evolved similarly in the treated and control occupations, before and after the German minimum wage reform. This is true when focusing on lower-skilled workers, the closer subsitutes to posted workers, in Panel C and D. This suggests that the reform had much larger wage effects for posted workers sent from low-wage countries, than for domestic workers that were presumably already covered by minimum wage agreements. In 2015, only about 15% of German employees earned below the minimum wage, and for these workers, the average wage increase was approximately 6% (Dustmann et al., 2022). In the food pro-

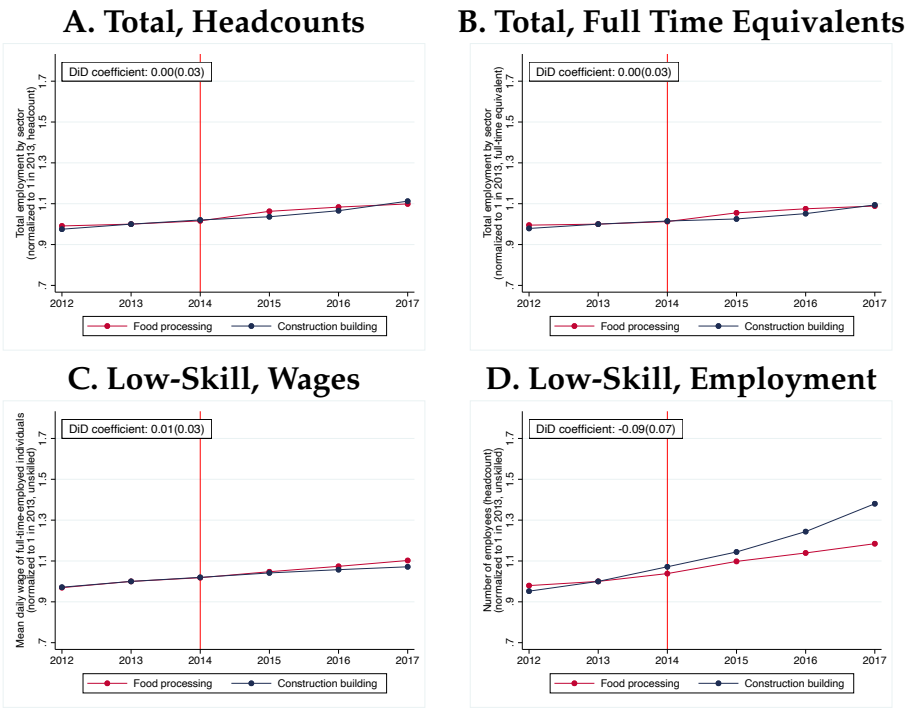
cessing sector, unskilled and semi-skilled workers earned about 62 euros per day (roughly 7.75 euros per hour), while in the construction sector they earned about 64 euros per day (8 euros per hour). Hence, the differential *domestic* wage increase due to the reform was almost nil.

I then show in Figure I.29 that the decline in employment of posted workers in Germany did not result in a noticeable increase in foreign employment in food processing jobs, although the corresponding estimates are noisy. Figure I.29 shows that German firms hired more foreign workers in the food processing sector after the reform, but foreign employment increased at the same rate in the construction sector. This finding is the same when focusing on lower-skilled workers, the closest substitutes to posted workers. This finding aligns with the small positive but insignificant responses in migrant stocks to changes in labor costs applied to posted workers in the gravity (Table D.7). Future analysis could focus on inflows of EU-origin workers and study the meat processing sector instead of the broader food-processing sector: I do not have this level of details in my dataset.

Finally, Figure I.30 shows that the *share* of temporary agency workers in the food processing sector increased. I focus on lower-skilled workers, the closest substitutes for posted workers.[13] This suggests that the reform led German producers to shift part of their workers from standard to temporary agency employment contracts within Germany. The economic activity structure in the food processing sector changed after 2014, leading German firms to reduce their reliance on cheaper labor services supplied by Eastern European firms, and to rely more on domestic outsourcing.

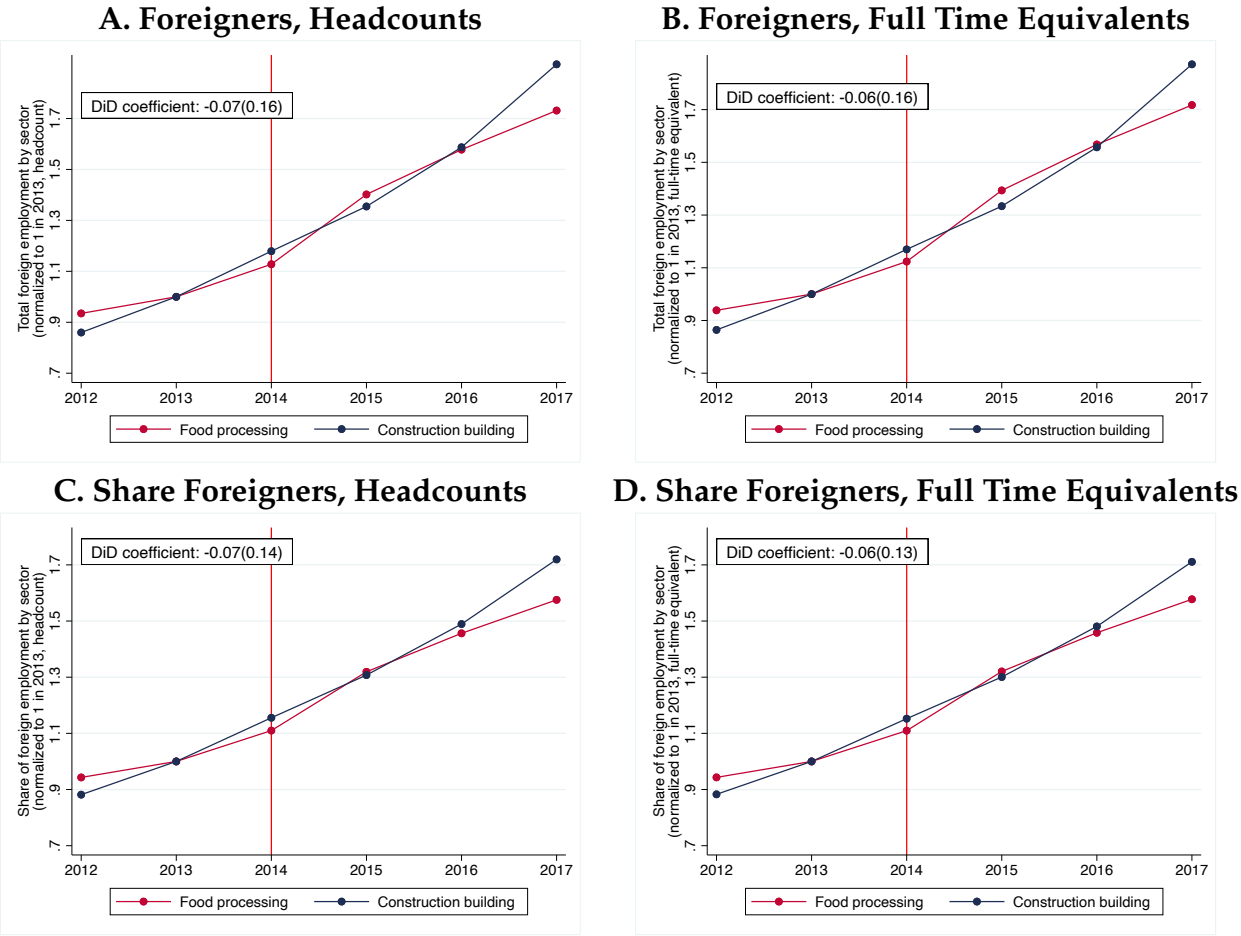
[13]Temporary agency workers are concentrated in this skill cell in both food processing and construction, In other skill categories, e.g., 2 to 4, the share of temporary employment agency workers is less than 1%.

Figure I.28: **Average Wages of Domestic (natives and foreigners) Workers in Germany**



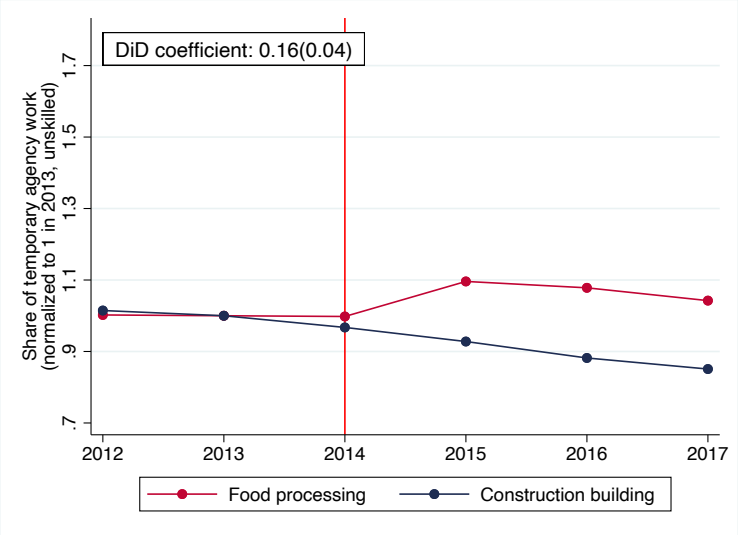

Notes: This Figure shows the evolution in the employment and wage of workers employed under German contracts (including natives and foreigners), in the food processing and construction sectors, before and after the German minimum wage reform (depicted by the vertical red line). The coefficient in the figure is the interaction coefficient estimated from Equation (2).

Figure I.29: **Employment of Foreigners (with German Contracts) in Food Processing vs Construction**




Notes: This Figure shows the evolution in the employment of foreign workers, employed under German contracts, in the food processing and construction sectors, before and after the German minimum wage reform (depicted by the vertical red line). The coefficient in the figure is the interaction coefficient estimated from Equation (2).

Figure I.30: **Use of German Temporary Employment Workers**




Notes: This Figure shows the evolution in the share of temporary employment agency workers, employed under German contracts, in the food processing and construction sectors, before and after the German minimum wage reform (depicted by the vertical red line). The coefficient in the figure is the interaction coefficient estimated from Equation (2).

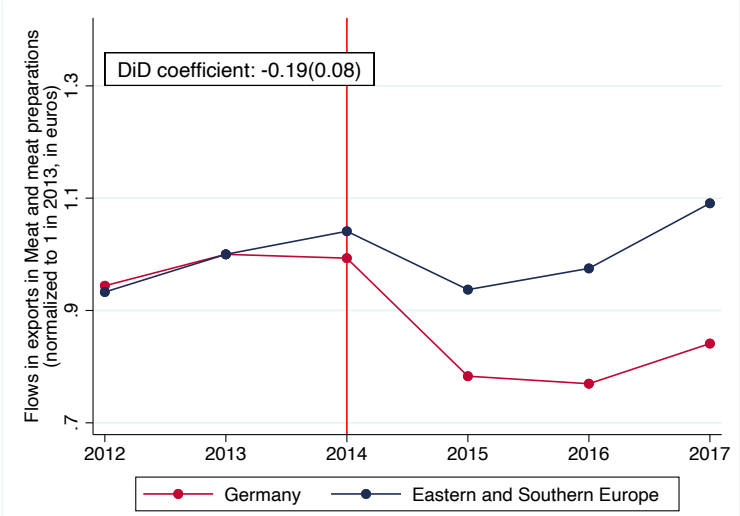
## I.3 Effects on German Exports of Meat

The reform could also have impacted the cost competitiveness of German exports of meat. I test this hypothesis using data on exports of meat products from all EU countries during the same period. I use data from the BACI dataset collected from Gaulier and Zignago (2010), that records trade flows in volume and expenditures, for each product code and each EU country.

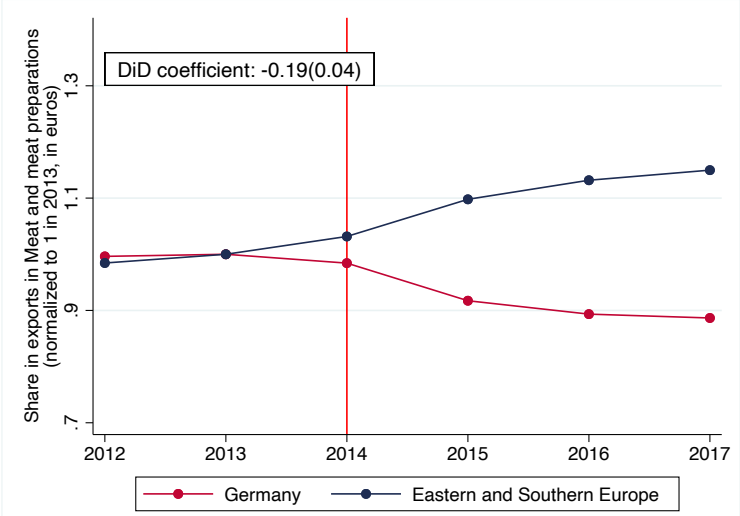
Figure I.31 shows that German exports of meat products declined substantially after the reform. Concurrently, the trade share of Eastern and Southern European countries increased. This suggests that a significant part of German firms' competitiveness in meat supply was driven by their ability to source cheaper labor services through posting. After German producers lost their ability to employ posted workers paid below the German minimum wage, their market shares decreased while those of Eastern and Southern European countries increased.

Figure I.31: **Exports of Meat and Meat Products**

**A. Value of Exports, in euros**




**B. Exports as a Percentage of Total EU Trade Flows**




Notes: This figure shows the evolution of trade shares by exporting countries, focusing on meat products. The data on exports of meat products (in volume and value) come from the BACI database.

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