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ABSTRACT

This paper studies how differences in labor market regulations shape countries' comparative advantage in the cross-border provision of labor-intensive services, using administrative data in Europe for the last two decades. I exploit exogenous variation in labor taxes and minimum wages faced by exporting firms engaged in a large European trade program. Firms from different countries compete to supply the same physical service in the same location but their employees are subject to different payroll taxes and minimum wages. These rules varied across countries, sectors, and over time. Reduced-form country case-studies as well as model-implied gravity estimates show evidence of large trade responses to lower labor taxes and minimum wages, with an elasticity that is around one. The Bolkestein directive, by exempting foreign firms from all labor regulations in the destination country, would have doubled exports of physical services from Eastern European countries, rationalizing the wave of protests in high-wage countries that led to the withdrawal of the proposal.

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A data appendix is available at <http://www.nber.org/data-appendix/w31876>

1 Introduction

It is a well-known theoretical result that trade is mutually beneficial because countries specialize in activities where they have a relative cost advantage. In public discourse, policymakers often emphasize benign sources of comparative advantages, such as factor abundance, technology, or economies of scale, leaving more politically controversial explanations aside. For instance, former WTO director Pascal Lamy once argued that lower taxes and weaker social standards are unlikely to govern international trade patterns because *"differences in wages largely reflect differences in labor productivity."*¹

In practice, labor markets are characterized by important features that are not fully consistent with this view. Most countries have welfare states that are largely funded by domestic taxes on labor and impose labor market regulations, such as minimum wages, to protect workers. There is also vast evidence that labor markets are characterized by market power (Card, 2022). While most economists now agree that differences in labor costs not only reflect true productivity gaps, but also differences in labor institutions and wage-setting power, we haven't fully grasped the implications of this new consensus for trade specialization and international trade patterns.

Yet, social standards could represent an entirely distinct form of comparative advantage, in contrast to conventional explanations of global competition. First, people find the idea that international specialization could stem from the distinct regulatory choices made by different countries unfair and unappealing (Di Tella and Rodrik, 2020). Second, if labor institutions cause trade, some countries might then be tempted to lower their standards to gain market shares in labor-intensive sectors, leading to inefficiently low levels of labor taxes and regulations (Krueger, 1996). This race to the bottom could stop certain countries from maintaining their preferred levels of redistribution and workers protection, which would lower political support for economic integration (Rodrik, 1998).

Despite its policy relevance, the role of social standards for international trade has remained underexplored partly due to important measurement and identification challenges. First, studying this question would ideally require jointly measuring the impacts

¹This is from a 2010 [speech](#) by Lamy on "facts and fictions" in international trade.

of regulations on unit labor costs, and the labor-content of trade flows, which are rarely observed in trade datasets (Rodrik, 1996). Second, credible exogenous variation in labor market regulations are needed to identify their causal effects on trade flows. Cross-country correlations between measures of social standards and trade competitiveness can be informative (Alesina and Perotti, 1994; Mah, 1997) but cannot distinguish the effects of different productivity levels from the effects of labor market institutions. Another approach is to look at the effects of domestic policy on exports (Gan et al., 2016; Malgouyres and Mayer, 2018). The issue is that when fundamental changes to domestic labor market regulations occur, those reforms can affect many other domestic factors, or can be directed at trade competitiveness itself, complicating identification.² Finally, even in the presence of clean variation and relevant data, labor regulations can be hard to translate into ad-valorem costs, making it difficult to interpret and extrapolate estimated elasticities, which can be crucial for welfare and counterfactual analysis (Arkolakis et al., 2012).

This paper tackles these challenges and provides evidence on the effects of payroll taxes and minimum wages –two key and common dimensions of domestic labor market regulations– on trade in labor-intensive services. I exploit a European trade program for physical services that offers three important advantages to study this question.

First, the EU posting policy allows countries to directly trade workers and labor institutions across borders, akin to the textbook model of trade in tasks proposed by Grossman and Rossi-Hansberg (2008). The policy regulates temporary contracts performed locally by foreign firms. For instance, a Polish construction firm (exporting country) can build in France (importing country) by sending its employees to France. These posted workers maintain their Polish employment contracts but physically work in France, serving the same customers, at the same location, using shared capital and infrastructure, all while operating under different employment laws. This setting keeps most determinants of comparative advantage constant while labor market regulations vary by origin of the ex-

²Furthermore, when sharp exogenous variation is available, researchers often focus on domestic responses (e.g Saez et al., 2019; Cengiz et al., 2019; Dustmann et al., 2022), because information on trade flows (and their labor content) is scarce, and because worker-level exposure designs are not well suited to the study of trade-related margins. An alternative approach is to study “responsible sourcing” (Harrison and Scorse, 2010; Boudreau, 2021; Alfaro-Ureña et al., 2021) or “fair trade” (Dragusanu, Montero and Nunn, 2022) policies that originate from consumers, activists or producers’ initiatives.

porting firm. Furthermore, disparities in labor productivity for physical services across countries are often limited (Balassa, 1964; Samuelson, 1964), making institutional factors plausibly the primary driver of wage determination for those workers.

Second, the EU Commission records payroll tax information on workers involved in cross-border physical service contracts within the EU. Thus, I have administrative records of trade in labor services and directly observe the number of workers involved in those cross-border transactions from 2009 to 2018. Those datasets have been previously used by Muñoz (2024) to measure the labor and product market effects of the posting policy. To study the different question of trade responsiveness to labor regulations in labor-intensive sectors, I have augmented those datasets with information on wages, payroll taxes and minimum wages applicable to firms engaged in the program.

Third, I can exploit many sources of variation in both tax policy and minimum wages to identify their causal effects on trade in labor services : (a) payroll taxes and minimum wages vary across countries and over time (b) the EU has imposed destination-based payroll taxation on some exporting firms (c) the EU has imposed destination-based minimum wages on some exporting firms. Together, these policy changes create compelling quasi-experimental variation to identify the causal effects of labor market regulations on trade in labor-intensive tasks within the EU.

I start by setting out a simple conceptual framework to illustrate how payroll taxes and minimum wages affect incentives to trade labor services in the EU. Foreign and domestic firms compete for the same service contract that must be performed “on-site”. The service is produced with labor only. Payroll taxes are origin-based: domestic and foreign firms face different tax rates, even if foreign and domestic workers are paid at similar wages and work at the same location. Minimum wages are destination-based: foreign firms must match the minimum legal wage abroad during the posting assignment. Suppliers of services can have different labor costs because (i) they hire workers in labor markets with different levels of (nominal) equilibrium wages (ii) they face different payroll tax rates, and (iii) they are differentially affected by destination-specific minimum wages. I use micro-level data on posted workers’ wages to quantify those sources of labor cost differences and to clarify the incidence of the payroll tax and minimum wage rules.

I then proceed to estimate the elasticity of posting flows to labor market regulations in the EU at three successive levels. I start by exploring simple cross-country correlations between labor cost differentials and cross-border supply of labor services. I find a strong negative correlation between bilateral posting flows and labor cost differentials, with an implied steady-state elasticity of -0.6. This suggests that labor cost differentials matter for trade in physical services in the long-run. In contrast, the relationship between bilateral trade in goods and labor cost differentials is weak and if any, marginally positive. Therefore, disparities in labor costs appear as an important driver of trade in labor-intensive services, but not as much in less labor-intensive activities.

I then turn to quasi-experimental evidence of posting responses to country-specific reforms in payroll taxes and minimum wages. I focus on several reforms that create compelling identifying variation and provide conclusive evidence of this relationship in the medium-run. Tests for pre-existing trends and a difference-in-differences framework validate using those reforms as a source of identification. For instance, I show that postings from Luxembourg dropped dramatically after a EU regulation suddenly imposed (much higher) destination-based payroll taxes on Luxembourgish exporters engaged in the program. In comparison, both the domestic supply of the same services, and exports of posting services in a sheltered sector, remained unaffected. The reduced-form elasticity of posting exports with respect to the exogenous change in labor costs for exporters is large. The size of the responses suggests that Luxembourgish firms were mostly competitive because of their lower origin-based payroll tax rate. After the reform forced foreign firms to pay the same tax rate as domestic firms, their exports shrank dramatically.

I also leverage a German reform that targeted the minimum wage component of wage costs for exporting firms. While Germany always had sectoral wage floors for German workers, these regulations did not apply to foreign firms, except in the construction sector. In 2015, Germany introduced a minimum wage that created a new wage floor for firms providing non-construction services in Germany.³ As a result of this reform, postings to Germany decreased by 60% in sectors affected by the change compared to the construction sector and neighboring importing countries. This implies a reduced-form

³[Dustmann et al. \(2022\)](#) previously studied domestic employment responses to this reform.

elasticity of posting flows of -1.3. Most of the reduction in exports to Germany came from firms in low-wage exporting countries that were highly exposed and had to match the new German minimum wage. In contrast, the effects on exporting countries, where the new minimum wage was not binding, are statistically insignificant. Reduced minimum wage requirements gave foreign firms a cost advantage in providing services in Germany before 2015. However, once they became subject to the same regulations as German firms, foreign suppliers of services became less competitive and lost market shares.

Finally, I present the results from the estimation of a theory-based gravity model, using all sources of variation in payroll tax rates and minimum wages across all EU countries from 2009 to 2018. This allows me to generalize my previous findings while exploiting a broader set of policy changes for identifying variation. Consistent with the reduced form results, I find large posting responses to changes in labor costs. My estimates of the model-implied elasticity range between -1.2 and -2.4 and are smaller than trade elasticities estimated for goods ([Head and Mayer, 2014](#)). Those year-to-year (short-run) posting responses to changes in wage costs are also smaller than the medium-run elasticities obtained from the country case studies. It takes several years for trade flows to fully adjust to permanent changes in payroll taxes and minimum wages. My difference-in-differences designs capture this long-term adjustment more effectively than the gravity estimation.

I use my estimates to assess the impact of various EU policy proposals on posting flows in Europe. Removing destination-based minimum wages from current posting rules would double the market shares of Eastern European countries in posting services. I show that this proposal, advocated by Eastern European countries after the EU enlargement, significantly reduced support for EU integration in a major French referendum. This aligns with [Rodrik \(1998\)](#)'s theory that voters reject sources of comparative advantage that are based on institutional choices that conflict with importing countries' social norms. Overall, the study of the EU posting policy illustrates how differences in labor market regulations not only affect global competition in labor-intensive services but also influence political support for economic integration.

Contributions This paper contributes to a broad literature investigating the sources of international specialization. Previous studies have often studied benign institutional determinants of trade such as institutional quality (Vogel, 2007), financial development (Manova, 2008), the security of contract enforcement (Levchenko, 2007; Nunn, 2007), or labor market rigidities (Helpman and Itskhoki, 2010; Cunat and Melitz, 2012).⁴ My focus is on two key and common elements of labor market regulations: minimum wages and payroll taxes. All countries must choose the level of payroll taxes that finance their domestic social insurance programs and the degree to which their minimum wage is binding. Throughout the paper, I call those domestic choices “standards” not to make the normative argument that it is better to have high taxes and minimum wages, but to emphasize that some countries have a preference for higher levels of redistribution and worker protection. I show that those standards play a substantial role in shaping specialization in labor-intensive sectors, even within a relatively homogeneous free trade area like the EU. This is consistent with a small but growing literature showing that international capital and trade flows are sensitive to differences in corporate taxation (Griffith, Hines and Sørensen, 2010; Tørslov, Wier and Zucman, 2018) or environmental regulations (Hanna, 2010; Shapiro and Walker, 2018). Imposing domestic standards on foreign firms is one kind of trade policy, hence my findings also relate to studies of trade responses to tariffs (Head and Mayer, 2014) and non-tariff barriers (Càrrere et al., 2022; Dhingra et al., 2023), although I provide the first estimates of the trade elasticity for labor-intensive services.

My findings raise the question of whether international coordination can prevent a race to the bottom in payroll taxes and labor protection. So far, most academic debates have been focused on limiting competition on corporate taxation (Avi-Yonah and Clausing, 2007; Auerbach, 2010) while neglecting payroll-based regulations because of two assumptions: capital is more mobile than labor, and payroll taxes are fully passed-through to wages.⁵ First, if capital has traditionally been viewed as very sensitive to international

⁴Those studies reviewed by Chor (2010) are mostly theoretical, but some present empirical tests. They correlate measures of an industry’s dependence on particular institutional conditions with countries’ relative export shares in those industries. Instead, I exploit quasi-experimental variations in labor regulations. There is also an earlier theoretical body of work that revisited the conventional findings of classical trade theory by integrating minimum wages (Brecher, 1974) or fair wages (Agell and Lundborg, 1995).

⁵This question is also related to the theoretical (Lerner, 1936; Feldstein and Krugman, 1990; Barbiero et al., 2019; Costinot and Werning, 2019) and empirical (Benzarti and Tazhitdinova, 2021) work on the trade

tax differentials (Kanbur and Keen, 1993; Keen and Konrad, 2013), there is increasing evidence that international movements of workers are responsive to income tax differentials (Kleven et al., 2020) and labor regulations (Naidu, Nyarko and Wang, 2016). Many policies or technological changes, such as posting or remote work, could make labor more mobile and more responsive to labor cost differentials. Second, the canonical competitive labor-market model predicts that the incidence of payroll taxes falls on workers' net market wages, leaving firms' labor costs unchanged. I find that payroll tax reforms were able to affect trade competitiveness in labor services, which is consistent with employment responses to payroll taxes documented elsewhere (Saez, Schoefer and Seim, 2019; Ku, Schönberg and Schreiner, 2020). In the EU context, imperfect wage adjustments can be rationalized by nominal rigidities, including minimum wages. My empirical designs also let me document dynamic adjustments of trade flows to tax reforms. I find that responses grow over time, which goes against the usual expectation that payroll tax cuts ("fiscal devaluations") can only boost exports in the short-run (Farhi, Gopinath and Itskhoki, 2014).

The paper is organized as follows. Section 2 describes the institutional setting and sets out a conceptual framework guiding the empirical analysis, Section 3 describes the data. Section 4 shows reduced-form graphical evidence and Section 5 presents gravity regression estimates. Section 6 discusses policy counterfactuals. Section 7 concludes.

2 Description of the EU Posting Policy

2.1 A Large Trade Program for Physical Services

I study the relationship between labor market regulations and trade in a large EU program called the posting policy. Established in 1959, this law regulates temporary contracts performed locally by foreign firms. It allows firms located in the territory of one member state to send their workers in any other member state to perform a temporary service contract.⁶

neutrality of value-added taxes.

⁶Posting is known as mode IV export of services in the WTO general framework for trade in services, and is part of the general agreement on trade in services (GATS). It is not specific to the EU and exists in many other areas of the world, although mode IV is much more regulated elsewhere.

This policy was first described by [Muñoz \(2024\)](#): posting accounted for one third of all within-EU trade in services in 2017 (2% of EU GDP), while 2 million workers (in full time equivalents) were involved in these cross-border transactions in 2019. Posting contracts mostly cover labor-intensive activities: the first sector is construction, followed by manufacturing services, road transportation, temporary employment agencies and agriculture. Hence, the vast majority of posted workers are blue-collar workers.

Regulatory costs Posting was established as part of the four economic freedoms in the EU. Its aim is to facilitate cross-border supply of services by minimizing regulatory costs. Foreign companies can directly serve customers in other EU countries; there is no need to open an establishment in that country. Foreign firms do not need to obtain a license or a work authorization to access foreign markets. Though the policy is intended for temporary service supply, there is no legal limit to posting contracts. Exporting firms must only fill out an administrative form which allows their employees to claim formal employment and insurance in the exporting country while effectively working abroad.

Labor Market Regulations The general principle of posting is that firms (and their workers) are subject to regulations in the country of origin, which is defined as the country where the firm exerts its “usual activity.” Posting was initially conceived with the idea that there should be no differences in the treatment of firms exporting washing machines or construction services; in theory, all regulations should be set in the country of origin.

In the 1990s, this initial legal framework underwent changes due to concerns about unfair competition among Western EU states. Although trade barriers are generally not allowed in the common market, the first Posted Workers Directive was voted in 1996 with the aim to prevent “social dumping.” This new legal framework allowed member states, under certain conditions set by the EU, to impose *some* of their domestic standards on foreign firms engaged in the program.

First, importing countries can impose some components of their labor law on exporting firms. The EU directive sets the “hard core” of domestic labor regulations that can be extended to foreign firms: maximum hours of work per week, safety and hygiene, equal

pay between men and women, and minimum legal wages. The domestic minimum legal wage only applies to foreign firms that would pay their workers below that level otherwise; it does not apply to self-employed individuals that post themselves abroad. Furthermore, only wage floors defined as “generally applicable” by domestic law are binding for foreign firms. Other wage floors (e.g. set at the branch or firm level) only apply to domestic workers, not posted workers. All labor regulations that are outside the “hard core” of rules listed in the EU directive and described above do not apply to foreign firms.

Second, payroll taxes become destination-based if posting contracts last more than a certain duration. This duration was 12 months until 2010, 24 months from 2010-2020, and 18 months since 2020. Since 2010, payroll taxes also became destination-based for temporary employment agencies located in border regions that post workers abroad.

Since 2020, the scope of domestic rules that can be applicable to foreign firms has been extended by a new EU directive. Posted workers must now receive the same *pay* as domestic employees (including some bonuses and other components of compulsory salary) at the receiving firm and become covered by some collective labor agreements in the importing country. This reform, pushed by Emmanuel Macron after his election in 2017, was based on the argument that the bulk of wage differences between origin and destination countries came from remaining regulatory differences, and that the minimum wage rule was not sufficient to impose similar standards on both domestic and foreign firms.

Enforcement Importing countries have no right to refuse the intervention of foreign suppliers of services in their territory, but can control that foreign firms comply with posting rules. They can perform inspections on job sites where the foreign firms and their employees are operating. They can also request that exporting firms fill out a form (“notification”) when operating in their territory.⁷ The enforcement of domestic standards is facilitated by the fact that exported services are performed in the importing country’s territory. This contrasts with the enforcement issues usually associated with responsible sourcing policies (Alfaro-Ureña et al., 2021), where importing countries (or multinationals) can hardly control production processes abroad.

⁷However, as stated in the EC Court of Justice jurisprudence “reporting requirements in importing countries should not serve the purpose of imposing higher barriers on foreign suppliers of services.”

While the enforcement of “social standards” is likely much easier in posting than in other forms of trade, it plausibly remains weaker than the enforcement of domestic regulations for domestic workers. For instance, violations of some EU rules – e.g applicable minimum wages and the maximum number of hours– have been documented in various policy reports. In practice, I will always estimate “intent-to-treat” effects of changes in labor regulations, assuming perfect compliance of exporting firms engaged in the program.

2.2 Conceptual Framework of Trade in Services with Social Standards

I lay out a simple conceptual framework that summarizes those rules and clarify how labor market regulations interact with trade in posting services. The model serves two purposes: explaining the conceptual role of changes in labor market regulations on posting flows and guiding the empirical analysis of the labor market regulations reforms. The model suggests what regression to run, what the coefficients in that regression should identify and outlines which endogeneity problems seem particularly worth worrying about.

2.2.1 Labor Cost Differences in Posting

To produce services in country j , firms in country i must pay a hourly wage w_i to their employees hired in country i . Firms also pay payroll taxes τ_{ij} , and those payroll taxes vary by importing and exporting country due to specific rules in the posting program. Finally, exporting firms must also pay an additional wage component to posted workers to reach the minimum legal wage in the importing country \bar{w}_j . I call this the posting allowance. This term is zero if the importing country does not have a minimum legal wage ($\bar{w}_j = 0$), if the exporting country’s wage level is higher than the minimum wage abroad ($w_i \geq \bar{w}_j$), or if the service is produced at home ($j = i$). The hourly labor cost for services performed by workers posted from i to j is:

$$\left\{ \begin{array}{l} \underbrace{c_{ij}}_{\text{labor cost to export from } i \text{ to } j} = \underbrace{w_i}_{\text{wage in } i} + \underbrace{\tau_i \cdot w_i}_{\text{payroll taxes}} + \underbrace{\mathbb{1}_{w_i < \bar{w}_j} (\bar{w}_j - w_i)}_{\text{posting allowance for min. wage}} \\ \underbrace{c_{jj}}_{\text{labor cost to produce in } j} = \underbrace{w_j}_{\text{wage in } j} + \underbrace{\tau_j \cdot w_j}_{\text{payroll taxes}} \end{array} \right. \quad (1)$$

To keep the conceptual framework as general (and simple) as possible, I do not take a stance at the determination of the equilibrium wage w_i and thus do not model wage-setting. It is worth noting, however, than in a standard Ricardian model like [Balassa \(1964\)](#) and [Samuelson \(1964\)](#), each country has the same productivity in physical tasks but wages for service workers differ across countries because of differences in outside options that are set by wages (and productivity) in the tradable sector. In standard trade models, services are not traded and wage setting in the service sector therefore does not matter for international trade patterns. But posting allows trade in formerly “non-tradable” services, turning wage differences in services into a potential source of relative cost advantage. As I will discuss later, an important question in this context is whether the outside option for workers sent from Poland to France is the equilibrium wage in France or in Poland.⁸

To summarize, firms competing to produce services can have different costs because (i) they face different equilibrium wages (ii) they have different labor tax rates and basis, and (iii) they are differentially affected by destination-specific minimum wages. In [Section 3.3](#), I use micro-level data on posted workers’ wages to describe and validate those three sources of labor cost differences, and to clarify the incidence of labor regulations on net wages paid by exporting firms engaged in the program.

2.2.2 One Model of Trade in Physical Services

I use the workhorse [Eaton and Kortum \(2002\)](#) model to show how cost differences showed in [Equation \(1\)](#) shape countries’ market shares in physical services. 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 denoted $z_i(n)$. Unit labor costs in sending countries are gross wages paid to workers divided by productivity. Supplying services from country i to country j also

⁸[Grossman and Rossi-Hansberg \(2008\)](#) and [Rodríguez-Clare \(2010\)](#) previously approached this question theoretically. In their models, offshoring allows firms to pay workers with the same productivity at different wages (set in the foreign and home country). Both papers emphasize that immigration prevents firms from exploiting the same wage differences, because wage discrimination for otherwise comparable foreign and domestic workers will be harder. In workhorse trade models, the ability for firms to mark-down wages of similarly productive workers is the source of efficiency gains from trade, while the common view in the labor literature is that market-power over migrant workers is a source of inefficiency ([Naidu et al., 2016](#)).

generates bilateral mobility costs m_{ij} . The unit cost for posting services from i to j is:

$$\underbrace{C_{ij}(n)}_{\text{unit cost to export from } i \text{ to } j} = c_{ij} \cdot m_{ij} \cdot \frac{1}{z_i(n)} \quad (2)$$

There is perfect competition across service suppliers. As in [Head, Mayer and Ries \(2009\)](#), each service is purchased from the country that offers the service at the lowest unit cost, including bilateral mobility costs. A service n is exported from i to j if and only if:

$$C_{ij}(n) \leq \min_{i' \in S} \{C_{i'j}(n)\} \quad (3)$$

Using the assumption of Frechet distributed productivity with $F_i(z) = \exp\{- (T_i z)^{-\theta}\}$, I can derive for each service n the probability that country i provides the lowest price service in country j . The density distribution of productivity together with the condition for optimal sourcing choices sets the total number of postings from i to j . The share of services in country j performed by suppliers from country i is:

$$\lambda_{ij} = \frac{T_i (c_{ij} \cdot m_{ij})^{-\theta}}{\sum_{k \in S} T_k (c_{kj} \cdot m_{kj})^{-\theta}} = T_i (c_{ij} \cdot m_{ij})^{-\theta} \Phi_j^{-1}, \quad (4)$$

where $\Phi_j = \left[\sum_{k \in S} T_k (c_{kj} \cdot m_{kj})^{-\theta} \right]$.⁹ Denoting S_j the total demand for labor services in country j , the volume of posting contracts exported by i to j is:¹⁰

$$S_{ij} = S_j T_i (c_{ij})^{-\theta} m_{ij}^{-\theta} \Phi_j^{-1}. \quad (5)$$

Elasticity The parameter θ is the elasticity of posting with respect to changes in wage costs c_{ij} ; it is the counterpart of the standard trade elasticity but for physical services. Imposing domestic standards on foreign employees mimics the trade protection effect of

⁹Note that λ_{ij} is the fraction of services that $j \in S$ purchases from $i \in S$, but [Allen and Arkolakis \(2016\)](#) emphasize that the Frechet distribution implies that the distribution of prices of goods (or services) that country j actually purchases from any country $i \in S$ will be the same. [Allen and Arkolakis \(2016\)](#) thus show that with [Eaton and Kortum \(2002\)](#) and Frechet productivity shocks, the fraction of goods purchased from a given origin is equal to the fraction of income spent on goods from a given origin. I focus on trade shares in quantities to fit my data on number of services exported from one country to the other.

¹⁰As any gravity model, this model can be solved in general equilibrium by using macro-level restrictions (e.g trade balance and market clearing), see [Head and Mayer \(2014\)](#).

a bilateral import tariff. To see this, consider France, an importing country with high redistributive standards funded by an average 40% employers' payroll tax rate, and high labor regulation standards with a 11 euros minimum legal hourly gross wage (set at 60% of the median wage). If France imposes French payroll tax rates on foreign firms supplying services in France, the increase in wage costs will be high for Polish firms that previously faced a 15% payroll tax rate, while Belgian firms will not see a difference since Belgian labor taxes are also high. Similarly, the posting allowance that foreign firms must pay to reach the French minimum wage will be large for firms located in low-wage countries, but is not binding for firms located in high-wage countries. These types of identifying variation will identify θ conditional on factors that vary at the importer and exporter level in Equation (5).

Discussion If imposing domestic regulations on foreign firms mimics the trade-protection effect of a tariff, the incidence of this instrument is different. Social standards do not mechanically increase collected revenues for importing countries. Rather, they are supposed to benefit foreign workers, while increasing prices for domestic customers.

My framework also ignores several interactions between social standards and relative-cost differences. First, labor market regulations solely influence the demand for foreign services via their impact on labor costs. But if consumers value higher social standards for foreign workers, or associate better protections for posted workers with more safety or better quality, the demand for foreign services could increase, even if the prices increase due to higher regulations. Second, in the model, taxes and minimum wages only impact relative cost differences through producers' labor costs, although better social norms could affect countries' productivity in producing services too.

3 Measuring Trade in Labor Services and Labor Costs

3.1 Datasets on Cross-Border Supply of Labor Services (S_{ij})

A1 Posting Forms I use administrative social security forms ("A1") issued for each posting contract within the EU. This form is a mandatory document filed by exporting firms

that workers must hold during their assignment abroad to prove their formal employment and insurance in the origin country. I collected all posting forms issued and received by 25 European member states from 2007 to 2018 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. Compared to standard custom data, this dataset directly measures the number of workers involved in the production of the service abroad. There is also no minimum reporting threshold, which minimizes missing flows. I use the gravity dataset from [Head and Mayer \(2014\)](#) to obtain additional information on bilateral trade in goods, GDP and geographic distance for each origin-destination country pair in my posting dataset.

The dataset records posting flows for each origin and destination country each year. One limitation is that when workers are sent by their firm to more than one country in a given year, only one A1 form is issued by the sending country, and this form cannot be linked to a specific receiving country. This means that this dataset under-estimates imports of labor services, but exports (and thus posting flows aggregated across exporting countries) are not affected by this data limitation. For more recent years, I observe the average duration of posting contracts by exporting countries. For a subsample of six exporting countries (Poland, Romania, Luxembourg, Lithuania, Czech Republic and Hungary), I also obtained the same bilateral flows further disaggregated by sector categories.

Additional Posting Registries In France, Belgium and Luxembourg, I further have access to micro registries of posted workers. Those datasets come from country-level registration tools that supplement the A1 forms in some receiving or sending countries. Compared to the EU-wide dataset, those registries have a higher coverage (when focusing on imports) because they register all incoming posting contracts regardless of the number of countries the posted workers are serving in during the year. They also provide more granular information on the duration of posting assignments, the wages paid to posted workers, and 5-digit sector activities of exporting and importing firms.

In Belgium, foreign companies must file a posting notification (“LIMOSA”) when sup-

plying a service there. I have access to all disaggregated posting contracts performed in Belgium since 2010. In France, foreign companies must file a posting notification (“SIPSI”) when supplying a service there. I observe the aggregate number of posting contracts performed in France since 2005. Since 2017, SIPSI has to be filed electronically, hence I observe disaggregated posting contracts in France for 2017-2020, with detailed information including posting contracts’ duration and workers’ wages.¹¹ In Luxembourg, I have access to a matched employer-employee dataset that covers the universe of firms in Luxembourg with information on whether a given worker is posted abroad each month.

I use those additional national registries for several purposes in the paper: (i) obtaining measures of posting contracts at the 5-digit industry level to study sectoral reforms (ii) obtaining additional measures of aggregate imports of posting inflows (iii) studying the distribution of posting contracts’ duration around regulatory thresholds for destination-based taxation (iv) studying the wage distribution of foreign workers around regulatory thresholds introduced by the minimum wage regulation and (v) performing “out of sample” checks using an alternative data source to study the effects of the same reform.

3.2 Datasets on Employers’ Labor Cost (c_{ij})

I measure each component of hourly labor cost for each importing and each exporting country using data collected from Eurostat, taking into account the variation introduced by specific rules in the EU posting program. I measure wages using the labor cost indicator (LCI) dataset from Eurostat, available from 2009 to 2018. It measures the average hourly gross wage (in euros) paid by employers and is built from national firm-level administrative datasets. The LCI dataset also measures the non-wage component of labor costs in each country. It is based on paid social security contributions and labor taxes minus subsidies received by employers. To distinguish social security contributions from other taxes and subsidies, I also collect social security contribution statutory rates for em-

¹¹Due to this change, 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 series by using information on A1 posting forms. I compute the ratio between A1 and SIPSI forms in 2016, and constraint this ratio to remain equal in 2017. This enables me to compute how much of the change in SIPSI forms in 2017 is driven by the move to electronic filling. I then use this factor to scale-down SIPSI inflows after 2017. I show estimates using raw and adjusted series when using this dataset in Subsection 4.2.1.

employers from the OECD Taxing Wages Dataset. This more directly reflects policy changes by recording the legal rates faced by employers in each country. Finally, I collect information on nationwide minimum legal wages for the same period.

Figure 1 illustrates the disparities in gross wages, payroll taxes, and minimum wages within the EU. Despite the absence of regulatory barriers to trade and migration in the single market, Panel A shows that differences in gross hourly wages (that partially reflect differences in productivity levels) are large. Panel B adjusts those wages by prices. There is less dispersion in real than nominal wages but the EU still experiences substantial heterogeneity in real wages.

Panel C and D show the differences in payroll taxes and minimum wages in the EU. For instance, France and Luxembourg have relatively similar levels of gross wages, but payroll taxes are three times higher in France. Countries with similar wage levels do not mechanically have similar minimum wages. The minimum wage is set at 60% of the median national wage in France, against 45% for the Netherlands. Finally, some countries like Sweden, Italy or Germany (before 2015) do not have a minimum wage established by law and choose branch-level or firm-level wage floors instead. Figure 1 highlights the diversity in social insurance systems across EU member states.

Of course, Figure 1 only captures some of the heterogeneities in labor market regulations across EU member states. For instance, domestic rules on severance payments, employment termination, or worker protection also vary across countries and matter for labor costs. I will not be able to directly measure those sources of wage cost heterogeneity nor isolate their causal effects on posting use. My main empirical design will instead control for those (permanent) differences in labor regulations by only exploiting changes in the components of wage costs that I can accurately measure.

3.3 Descriptives on Wages and Incidence of Labor Rules in Posting

Combining information on hourly gross wages, employers' effective labor tax rates and minimum wages with the rules described in Equation 1, I can reconstruct the yearly hourly wage cost for employers exporting labor services from country i to country j . This requires the assumption that nationwide average wages are a good proxy for the equilib-

rium wages of posted workers. For instance, if the equilibrium wage for posted workers in the origin country is above the average wage in that country, I could wrongly infer that destination-level minimum wages are binding for exporting firms. Similarly, if domestic workers supplying services at home are paid at the minimum wage, I could over-estimate differences in wage costs between foreign and domestic firms. Finally, the incidence of payroll taxes and minimum wage requirements on net wages also matters to correctly measure labor cost differences across countries. Fortunately, micro-level data on posted and domestic workers' wages helps gauge the credibility of those assumptions.

Figure A.1 starts by showing that most posted workers sent to France are paid exactly at the French minimum wage. This is evidence that the wage floor enforced by the EU policy is binding, and that exporting firms would pay lower wages absent the minimum wage requirement. On the contrary, French workers competing with posted workers are paid close to the French average wage level, and way above the French minimum wage. In 2018 the average wage of French workers employed at French firms importing posting services was 21.1 euros while the nationwide average hourly wage was 24 euros, and the French minimum wage was around 10 euros. Thus, foreign and domestic firms face different equilibrium level of wages to hire workers to supply the same tasks. This wage gap could stem from unobserved differences in workers' ability. However, [Muñoz \(2024\)](#) documents substantial within-workplace differences in gross wages paid to posted and domestic workers, even after accounting for tenure or productivity (e.g worker fixed effects). This suggests that there are enough institutional and information frictions to enable wage discrimination between posted and domestic workers, as in offshoring ([Grossman and Rossi-Hansberg, 2008](#)) or outsourcing ([Katz and Krueger, 2019](#)).¹² Those gross wage differences (that do not account for differences in payroll taxes) also reflect differences in labor regulations. For instance, a French worker will be paid extra for working at night, in the evening or in the week-ends. They will be protected by additional firm-level or branch-level wage floors but those domestic rules won't apply to posted workers.

¹²Posted workers are bound to their exporting firms, making it hard to switch jobs during the contracts or to renegotiate wages. Those observed wage differences also suggest that competition between exporting firms is too weak to pull up wages of foreign workers as much as for domestic workers. This likely occurs because the share of posting firms remains small in destination countries. [Albert and Monras \(2022\)](#) also emphasize that temporary migrants can have lower reservation wages than natives.

Figure 2 then shows that firms located in different countries are differentially affected by destination-specific minimum wages. Most posted workers sent to France from countries where the average wage is below the French minimum wage are paid exactly at the French minimum wage (Panel A to C). On the contrary, posted workers' wages are much less concentrated around the French minimum wage when they are sent from high wage countries (Panel D to F). The posting allowance that foreign firms must pay to reach the French minimum wage is thus large for firms located in low-wage countries, but is not binding for firms located in high-wage countries. I can also document whether firms located in different countries must pay different compensating differentials when exporting workers to a given location. Figure A.3, Panel A, shows no positive relationship between the average wage paid to workers sent from country i to country j and the distance between i and j . This means that firms do not pay a compensating differential to their employees on top of the posting allowance required by the policy. I also observe non-monetary compensating differentials, which are not typically measured in datasets on migrant workers (e.g in Bryan and Morten, 2019). Panels B, C, and D show that the proportion of posting contracts with employer-provided housing, food, and transportation is greater when workers are sent from more distant locations. Those origin-destination specific costs microfound the bilateral iceberg trade-migration cost m_{ij} in the model.

The last key mechanism to bear in mind when considering Equation (1) is that gross wages can in principle adjust to tax reforms. The presence of nominal rigidities, including minimum wages, may restrict those market-level wage adjustments.¹³ My estimates of trade responses to total wage costs (c_{ij}) will capture potential gross wage responses to tax reforms. I will also estimate this elasticity with respect to the change in the statutory tax rate (τ_{it}), which will capture the reduced-form effect of payroll taxes without making any assumption on pass-through to net labor costs. The incidence of the posting allowance is clearer because it directly targets gross wages paid to employees. However, there is a possibility that exporting firms might pay the higher destination-specific minimum wage during the posting contract and then reduce workers' gross wages upon their return, leav-

¹³Similarly, targeted tax reforms (e.g at sectors or exporters) are often too narrow to lead to overall wage adjustments (Saez, Schoefer and Seim, 2019).

ing net labor costs unaffected. [Muñoz \(2024\)](#) shows that exporting firms match minimum wages during the posting contract, but wages return to pre-posting levels (and not lower) after the activity abroad concludes. This means that firms have limited ability to decrease posted workers' net wages after the end of the posting contract to compensate the effects of destination-specific minimum wage requirements.

4 Reduced-Form Graphical Evidence

I now turn to the estimation of posting responses to changes in labor taxes and minimum wages. I start the analysis by showing reduced-form graphical evidence of the impact of labor market regulations on cross-border trade in physical services. First, I study cross-country correlations between labor cost differentials and posting flows. This provides suggestive evidence that labor standards matter for the geography of trade in services in the long-run. Second, I consider salient country-specific reforms in minimum wages and labor taxes that create compelling identifying variation and provide conclusive evidence of this relationship in the medium-run.

4.1 Steady-State Correlation Between Posting Flows and Labor Costs

The model described in Section [2.2](#) predicts that trade in labor services should be larger within country-pairs where the total wage cost of exporting firms is much lower than that of domestic firms. [Figure 3](#) provides cross-country evidence on the relationship between bilateral trade and labor cost differentials. In each panel, I depict the best linear fit using a univariate regression with no country weights. I also estimate corresponding elasticities by regressing the log bilateral trade flows on the log destination-origin labor cost differential, and report the coefficient on the figure.

The top panel focuses on trade in physical services. Panel A1 shows the binned scatter plot of (log) bilateral posting flows and (log) destination-origin labor cost differentials for all country pairs during the 2009-2018 period. A tight relationship holds between the cross-border supply of labor-intensive services and labor cost differentials. Posting services tend to be exported from low to high labor cost countries, with a cross-sectional

correlation of $-0.58(.08)$. Panel A2 shows an equally large and even tighter correlation when focusing on differentials in the non-wage component of labor costs, e.g differences in social security contributions and other labor taxes. Although I do not have a direct measure of expenditures in trade in physical services, I can proxy it by multiplying the quantity of “traded” workers by their average contract duration and wage costs. The negative correlation holds when focusing on bilateral posting flows in values in Figure A.6, with a point estimate of $-.51(.11)$.¹⁴

The bottom panel of Figure 3 repeats this exercise for trade in manufacturing goods, that by definition must be less labor intensive than physical services. The cross-country correlation between bilateral trade in goods and labor cost differentials is weak and if any, marginally positive, with a point estimate of $.13(.07)$. The figure reveals that countries with similar levels of labor costs are also the one that trade large amounts of goods, a pattern that is not observed for trade in physical services. This means that other sources of relative cost differences must drive bilateral trade in goods, while labor cost differences appear as an important driver of trade in labor-intensive services in the raw data.¹⁵

Figure 3 is informative of the steady-state impact of labor costs on cross-border trade in labor-intensive services. Obviously, many factors are simultaneously correlated with employers’ labor costs and competitiveness in services, including differences in productivity levels that can be correlated with wages. Static comparisons across countries also load the effects of differences in other regulatory components of labor costs, for instance rules on employment termination. To properly estimate the causal effect of labor market regulations on posting flows, it is crucial to exploit exogenous variation in labor costs while controlling for these simultaneous factors. Next, I consider quasi-experimental variation created by tax and minimum wage reforms that alleviate these identification threats.

¹⁴The elasticity is equally large when weighting cross-border trade flows by wages (Figure A.5) and duration of posting assignments (Figure A.9) or when using employers’ social security contribution statutory rates as an alternative measure of labor costs (Figure A.7). Figure A.8 uses the log odd ratio $\ln(S_{ij}) / \ln(S_{jj})$ which is more consistent with the model in Section 2.2, the resulting elasticity is $-.52(.08)$.

¹⁵Figure A.2 shows that similar patterns hold when focusing on all traded services.

4.2 Country-Case Studies: Payroll Tax and Minimum Wage Reforms

This section studies posting responses to large and exogenous reforms in labor market regulations. I study four reforms: (i) a large payroll tax cut in one of the largest receiving countries (Belgium) (ii) the introduction of destination-based payroll taxation for exporters of temporary employment agency services (Luxembourg) (iii) the introduction of destination-based payroll taxation for contracts exceeding a certain duration (France) (iv) a minimum wage reform impacting firms supplying services in manufacturing (Germany). For each country-specific case study, Table 1 presents elasticity estimates using a difference-in-differences comparison of the treatment country and the control country (or sector) before and after the reform. Those estimates capture medium-term responses as I compare outcomes a few years before the reform to a few years after the reform. Tests for pre-existing trends validate using those reforms as a source of identification.

4.2.1 The Belgian Tax Shift

I first 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 2016.¹⁶ 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.¹⁷

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 post-

¹⁶The 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.

¹⁷The 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).

ing services in both countries. France and Belgium also share a border and are amongst the largest importers of posting services, which makes them comparable. 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 tax cut. Pre-reform trends allow me to test this assumption.

Figure 4 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.¹⁸ Belgium and France were importing posting services at a similar trend before 2015, suggesting that postings to France provides a credible comparable 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.

I compute the corresponding elasticity from a 2SLS regression of the form $\log S_{jt} = e \log c_{jt} + \gamma_t + \gamma_j + \varepsilon_{jt}$, instrumented with $\mathbb{1} \cdot (j = Belgium) \times \mathbb{1} \cdot (t \geq 2015)$. The implied estimated reduced-form elasticity of posting flows with respect to destination-specific payroll tax rates (τ_{jt}) is large with a point estimate of 1.45(.3). I then compute this elasticity with respect to total labor cost (c_{jt}), instrumented with the reform interaction. This specification now accounts for endogenous changes in equilibrium gross wages w_{jt} , although Figure A.10 shows no distinguishable wage responses to the reform. The elasticity with respect to the total wage cost, reported in Column (2) of Table 1, is 3.7(.7).

Panel B 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

¹⁸In 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.

intensive. I find no discernable response to the change in Belgian payroll taxes when focusing on trade in manufacturing goods. Overall, Figure 4 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.

Theory predicts that the payroll tax cut should also boost exports of posting services from Belgium. Figure A.11 confirms that the reform had large (but opposite sign) effects on exports of labor services from 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 compelling pre-trends.

The tax shift reform was not targeted at firms operating in specific sectors and is therefore not immune to the identification challenges outlined in the introduction. 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 A.12 repeats the analysis using imports as a fraction of GDP as an alternative 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. Finally, Figure A.13 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. The effects are qualitatively similar, thus the findings are not solely driven by using France as the control group, the elasticity is $0.6(.22)$ instead of $1.45(.32)$ in the baseline analysis.¹⁹

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 contem-

¹⁹Figure A.14 shows the raw series non adjusted for the change in reporting in SIPSI, leading to a larger estimated elasticity of $2.53(.75)$.

poraneous to the nationwide payroll tax cut. Next, I move to within-country reforms (in both exporting and importing countries) that alleviate those identification threats.

4.2.2 The EU Regulation for Destination-Based Payroll Taxation

I next study a EU reform that induced a sharp change in the tax rates faced by exporting firms *within* a given exporting country. A EU regulation was implemented in May 2010 to reform payroll tax rules in the posting program in contexts that could easily be interpreted as regulatory arbitrage. Before the reform, firms located in the lower-tax side of a border region could hire foreign workers under domestic contracts and immediately send them to their residence country as posted workers, which allowed them to avoid labor market regulations and taxes in the neighboring country. Such behavior was akin to foreign or domestic outsourcing (Antràs and Staiger, 2012; Goldschmidt and Schmieder, 2017), where firms undercut wage costs by moving some of their activity to alternative employment contracts or to other plants.

To end those practices, the new regulation required that firms located in border regions (“*regions transfrontalieres*”) pay payroll taxes in the destination country when supplying their services abroad. More specifically, those firms must pay destination-specific payroll taxes if they (i) post a worker that has not been affiliated to the home country social security system for at least a month or (ii) post a worker to its own country of residence (e.g French worker posted to France). Such practices were mostly documented between France and Luxembourg before the reform, and occurred almost exclusively through temporary employment agencies (Belkacem and Pigeron-Piroth, 2016).²⁰ In contrast, some sectors were exempted from the new law. Specifically, due to the highly mobile nature of international transportation and the difficulty in determining in which country international drivers “work,” a 10-year exemption was granted by the EU to firms operating in the sector.²¹ The 2010 change in EU regulation thus introduced an exceptionally nar-

²⁰Data from the ULEDI show that 82% of temporary employment agency workers in Luxembourg were French residents; this number is 20% when focusing on total private employment in Luxembourg. Most French workers posted to France are employed by temporary employment agencies located in Luxembourg.

²¹Those exemptions ended in April 2021 and sparked a wave of protests amongst workers and employers organizations in the international road transportation transport (see Luxembourgish Parliament questions 2021n3932/3966).

row but sharp increase in labor taxes for some exporters, but not others, keeping other determinants of foreign and domestic supply of labor services constant.

I can study the effects of this reform by using administrative matched employer-employee data for all firms in Luxembourg merged with information on all posting exports since 2006. In this dataset, I measure the number of (unique) workers employed in Luxembourg each month, with information on whether those workers are “posted” or not in that given month.²² The dataset also has 5-digit sector codes for each establishment. Hence I can measure the employment stock at home or posted abroad, in each sector and month.

Figure 5 shows graphically the differences-in-difference setting provided by the reform. The top panel plots the yearly stock of temporary employment agency contracts in Luxembourg from 2006 to 2017 (normalized to one in 2009 just before the reform) performed abroad through posting (treatment) and domestically (control). I also show the sharp variation in payroll tax rates induced by the reform (dashed line, right y-axis). Statutory payroll tax rates for temporary employment agencies increased from 15 to 44 percent for services exported through posting (due to destination-level taxes being higher), but stayed constant for contracts performed in Luxembourg. The identifying assumption is that placement agency services performed at home or abroad should be exposed to similar demand and supply shocks and should follow similar trends absent the reform.

The two series followed parallel trends before the reform, suggesting that services supplied domestically provide a credible counterfactual for exports of temporary employment services from Luxembourg. The series start to diverge immediately after the 2010 reform. The number of temporary employment services supplied abroad by posted workers decreased by 40% compared to the pre-reform level. In comparison, the number of temporary employment contracts performed domestically increased during the same period. To confirm that the reform caused the change in service exports patterns, Figure A.15 shows the same series as Figure 5, but at the monthly frequency. The drop in postings occurred in the exact month following the new EU regulation, while both series were following parallel trends in months preceding it. This is evidence that the change in payroll tax rates drove the change in posting exports from Luxembourg. The high-

²²The measure of employment in a given month is akin to measuring “full time equivalent” employment.

frequency data confirms the lack of anticipation of the reform, which contrasts with usual findings on tariffs where exporters are able to re-time some of their exports (Fajgelbaum et al., 2020).

I estimate the corresponding elasticity with respect to the change in wage costs. I obtain this elasticity from the 2SLS model $\log S_{LUjt} = e \log c_{LUjt} + \gamma_t + \gamma_j + \varepsilon_{jt}$, where S_{LUjt} is the total number of temporary employment services produced by firms in Luxembourg that are supplied domestically (e.g to $j = LU$, control) or abroad (e.g to $j = \text{abroad}$, treated). To exploit the exogenous shift triggered by the reform, the wage cost is instrumented with the reform interaction $\mathbb{1} \cdot (j = \text{abroad}) \times \mathbb{1} \cdot (t \geq 2010)$. Because the reform introduces within-sector variation in labor taxes over time, the inclusion of year fixed-effects in this specification filters out all general equilibrium effects in Luxembourg –e.g any i -specific time-varying term in Equation (5)– that affect similarly domestic and foreign demand for temporary employment services.

The reduced-form elasticity of posting flows with respect to the change in statutory payroll tax rates reported in the figure is large and significant, with a point estimate of -1.55(.24). This is very close to the point estimate obtained exploiting the change in payroll tax rate in Belgium. Using (instrumented) total wage cost in the regression yields a much larger elasticity of -5.3(1.9) three years after the reform (a similar time-window than in the Belgian reform), and an elasticity of -8.5(1.39) eight years after the reform. In some contexts, for instance in border regions or in the temporary employment sector where workers can be hired very flexibly, exports of labor-intensive tasks thus appear to be very responsive to differences in labor market regulations.

Despite the absence of differential trends before the reform, the drop in posting exports in 2010 could be caused by a shock affecting foreign customers in the same year. To test this assumption, I next move to a triple differences design, looking at the differential evolution of foreign and domestic activity in the sector that was sheltered from the reform. Figure 5, Panel B plots the yearly number of contracts in the road transportation sector in Luxembourg from 2006 to 2020 (normalized to one in 2009 just before the implementation of the reform) posted abroad (placebo treatment) and supplied domestically (control). In this sector where posting is also prevalent, but that was not targeted by the EU regulation,

posting contracts did not decline after 2010 compared to domestic activity. The implied (placebo) elasticity is zero and is statistically different from the elasticity estimated in the treated sector.²³ The absence of a response also indicates that there was no reallocation of economic activity from the exposed to the sheltered sector following the reform.

Using the placebo sector allows me to directly relax the parallel trends assumption required for identification in Figure 5, Panel A, by controlling for potential differences in pre-trends. Specifically, I can compare services that are exported to those that are supplied domestically in the temporary employment sector versus the road transportation sector, before and after that payroll taxes increase for exporters of temporary employment services only. Formally, I estimate the reduced-form elasticity from $\log S_{LUjst} = e \log c_{LUjst} + \gamma_{jt} + \gamma_{st} + \varepsilon_{jst}$, instrumented with the three-way reform interaction $\mathbb{1} \cdot (j = \text{abroad}) \times \mathbb{1} \cdot (t \geq 2010) \times \mathbb{1} \cdot (s = \text{temp. agency contract})$. The estimated elasticity with respect to the payroll tax rate is large and statistically significant at the one percent level even after controlling for those additional fixed effects, with a point estimate of -1.37(.08).

Another way to relax this parallel trends assumption is to investigate the effects of the reform on *imports* of posting services from Luxembourg in other countries. Specifically, 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 A.16 shows this alternative comparison in France, the main importer of Luxembourgish labor services before 2010.²⁴ Panel A shows that France cut by half its imports of all posting services from Luxembourg after the reform. 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.

The graphical evidence presented in this section shows large causal effects of labor taxes on exports of labor-intensive services. Luxembourgish temporary employment agencies were mostly competitive because of lower tax rates compared to their competitors.

²³I follow Kleven et al. (2013) and compute the placebo elasticity using the same tax differential as for eligible sectors in panel A of Figure 5.

²⁴France imported 71% of all posting services exported by Luxembourg in 2009.

After the reform cut this tax advantage, their exports dropped dramatically.

4.2.3 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. I now turn to 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 6, 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).²⁵ 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

²⁵Only 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.

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 2020.²⁶ The EU posting trade program 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 6 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).

4.2.4 The German Minimum Wage Reform

Using three quasi-natural experiments, I showed large and persistent trade responses to higher employers' payroll taxes, with elasticities above one. Next, I investigate how increasing exporting firms' wage costs through minimum wages, rather than payroll taxes, affect international competition for labor-intensive services in the EU.

I focus on Germany where no nationwide minimum legal wage was in place until 2015. In Germany, only construction-related industries were entitled to a minimum legal wage

²⁶The 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.

at the sectoral level since 1997.²⁷ Other sectors had wage floors for their domestic workers agreed at the firm or branch level: around 55% of German domestic workers were covered before 2015 (Dustmann et al., 2022). However, those standards were not legally “generally applicable” and therefore did not apply to posted workers employed by foreign firms. For instance, firms located in Romania were allowed to employ workers paid at 2 euros per hour (the minimum legal wage in Romania) while supplying services on Germany’s territory. This was particularly salient in the meat processing industry. In this sector, posted workers’ average wages were extremely low, around 3 euros per hour against 16.2 euros per hour for workers employed by German firms (Doelfs, 2012; Erol and Schulten, 2021).²⁸ Before 2015, posted workers represented 50% of the workforce in the German meat processing industry (Wagner and Hassel, 2016; Wagner, 2018). This situation led to vivid tensions at the EU level. In 2013, Belgium filed a complaint at the EU court of justice, arguing that Germany was gaining an “unfair competitive advantage” in the food-processing sector by using the absence of a minimum legal wage as a way to import cheap labor services from low-wage countries. This trade dispute laid the groundwork for the implementation of a minimum legal wage in Germany.

In August 2014, following pressures from the German government and the EU, the meat processing industry implemented a minimum legal wage (7.75 euros per hour) in the sector. In January 2015, a national minimum legal wage of 8.5 euros per hour was introduced and applied to all sectors in Germany. At the time, about 15 percent of German employees earned less than that amount (Dustmann et al., 2022). One important consequence was that foreign firms operating in non construction-related sectors also had to increase their posted workers’ wages to reach 8.5 euros per hour. The reform was only binding for foreign firms previously paying their workers less than 8.5 euros per hour. Foreign firms supplying construction services were not directly affected because they were already constrained by the German minimum sectoral wage, that was above

²⁷The Posted Workers Directive including minimum wages in the “hard core” rules applicable to foreign firms was passed in 1996 and was adopted in Germany in 1997 (“AEntG” or posted worker act). This law created the first legal basis for minimum sectoral legal wage in Germany. Since 1997, sectoral minimum legal wages in Germany must be implemented through the addition of branches in the AEntG scope.

²⁸Wages of posted workers could be as low as 1.50 euros per hour (Hassel, Steen Knudsen and Wagner, 2016). Wagner (2018) provides an in-depth historical perspective on the German meat processing industry and the role of exploitative labor conditions for posted workers in its economic development.

8.5 euros per hour at the time. The resulting change in wage costs was much larger for foreign than domestic workers. [Dustmann et al. \(2022\)](#) document an average 6% wage increase for German workers previously earning less than 8.5 euros per hour, and a 10% increase for the most affected domestic workers. The same reform automatically raised wages for foreign workers by an average of 40% and doubled wages for those sent from the poorest countries.²⁹

I study how the use of posting services responded to this reform by using data on *sectoral* posting exports that are only available for a subset of six exporting countries: Poland, Luxembourg, Hungary, Czech Republic, Lithuania, and Romania. I observe posting services exported by firms located in those countries in both the manufacturing and construction sectors, to each destination country. Panel A of [Figure 7](#) shows the difference-in-differences setting provided by the reform. It plots the yearly number of posting services exported to Germany by the exposed exporting countries (normalized to one in 2013) in the construction sector (control) and manufacturing industries (treated), before and after the minimum wage reform depicted by the vertical red line. The dashed line shows the evolution of exporting firms' wage costs in the treated versus control sector, before and after the reform. 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 foreign firms' wage costs in the non-construction sectors 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 minimum legal wage was implemented in the meat industry. Postings to the German manufacturing industries decreased further in 2015 when all manufacturing industries became treated by the minimum wage reform. At the same time, foreign supply of construction services stayed stable and close to their pre-reform level.

The implied reduced-form elasticity can be obtained from the 2SLS regression $\log(S_{st}) = \alpha + e \log(c_{st}) + \gamma_t + \gamma_s + u_{st}$ where S_{st} denotes aggregate exports of posting services to Germany in sector s and c_{st} is the average hourly wage cost for exporting firms that

²⁹This is a lower bound estimate by assuming that posted workers were paid at origin-specific average wages instead of origin-specific minimum wages before 2014. I do not observe the wages paid to posted workers in Germany (only the number of workers) and thus cannot compute those changes directly.

operate in Germany in sector s . I instrument the wage costs by the reform interaction $\mathbb{1}(s = \text{manuf. services}) \cdot \mathbb{1}(t \geq 2014)$. As in Figure 5, year fixed-effects control for nationwide demand and supply shocks in Germany. The estimated coefficient is again large and statistically significant with a point estimate of $-1.34(.43)$.

To verify that the the drop in German imports of manufacturing services is not driven by other sector-specific shocks that would affect the demand for those services even in the absence of the reform, Panel B plots the same differential evolution in Germany's (high-wage) neighboring countries, where minimum wage requirements for foreign firms stayed constant. Those countries kept importing construction and manufacturing labor services at the same rate during this period. The implied placebo elasticity is non statistically different from zero, and is statistically different from the elasticity estimated in the treated importing country, Germany. This rules-out sectoral shocks in exporting countries that would affect their exports to other destination countries as well.³⁰

Another concern is that the minimum wage reform affected the demand for posted workers in German manufacturing sectors through other channels than through the change in wage costs for foreign firms. For instance, if the reform had larger effects on domestic employment in the manufacturing versus construction sectors, this could have affected the demand for foreign services too. To make progress on this issue, I take advantage of exogenous variation *within* the treated industry across sending countries. The identifying variation comes from the *kinked* relationship between the wage cost shock caused by the reform and the pre-reform wage level in sending countries, illustrated in Panel A of Figure 8. The new regulation makes exports more costly in exporting countries where the new minimum wage is binding compared to countries where it is not. One identification strategy is thus to compare how *within* the treated German sector, posting flows from exposed versus non-exposed countries evolved differentially relative to the non-exposed sector, before and after the reform. This filters out sector-level effects of the minimum wage reform by only exploiting heterogeneity in how binding the new rule is across sending countries. In spirit, this is similar to comparing the employment responses of German

³⁰Figure A.17 shows the same analysis but excluding exports from Romania; because nationwide restrictions to postings and migration were lifted in 2014 for Romanian citizens (see Table B.3). The graphical patterns and estimated reduced-form elasticity are similar.

workers earning more or less than the new minimum wage before the reform (Dustmann et al., 2022).

To do so, I estimate separately for each sending country an equation of the form $\log(S_{ist}) = \alpha + \gamma \cdot \mathbb{1}(s = \text{manufacturing}) \times \mathbb{1}(t \geq 2014) + \mathbb{1}(s = \text{manufacturing}) + \mathbb{1}(t \geq 2014) + u_{ist}$ where S_{ist} denotes postings from country i to Germany in sector s and year t . The coefficient γ captures the effect of the reform on country i 's exports of labor services to Germany in the treated sector, relative to the control sector. Panel B of Figure 8 shows the estimates of γ on the y-axis and the origin-specific change in wage cost caused by the reform in the treated sector on the x-axis. Estimated posting responses to the minimum wage reform increase monotonically with the degree to which the minimum wage binds, suggesting that the heterogeneity captures the differential exposure to the new requirement. Exporting countries that faced the largest changes in wage costs due to their low initial level of wages at home (countries on the left of the x-axis in Figure 8) had greater reductions in their exports to Germany in the treated sector. In contrast, the treatment effect for the exporting country where the new German minimum wage was not binding (e.g Luxembourg), plotted in light blue, is not statistically different from zero. This suggests that market share was not reallocated from exposed to non-exposed countries within the importing country, which is similar to the finding, shown in Figure 5, that there was no reallocation across sectors within a treated exporting country. Overall, Figure 8 confirms that the change in wage costs for exporters located in low-wage countries was the prime driver of the aggregate drop in exports to Germany in the treated sector.

As a final falsification test, I repeat the same heterogeneity analysis focusing on importing countries that did not change minimum wage requirements during the same period. The placebo trade responses γ estimated using the same specification for the same exporting countries but in Germany's high-wage neighboring countries are plotted in Figure A.18. Those responses are not statistically different from zero and are not decreasing by origin-specific wages. This again rules-out sector-specific shocks in exporting countries that would affect their supply of services in all destination countries, not only Germany. This also confirms that Figure 8 captures the effects of the German reform, rather than a mechanical pattern that would be observed even without it.

This section showed clear graphical evidence that foreign firms' competitiveness in providing labor services in Germany was due to their ability to undercut German minimum wages. After foreign firms became subject to the same labor regulations as German firms, their exports decreased by more than half. It is worth emphasizing that [Dustmann et al. \(2022\)](#) find limited effects of the same reform on *German* employment (posted workers do not appear in German employment statistics), but with substantial reallocation from less to more productive German firms. That the reform decreased foreign firms' competitiveness in supplying services through posting (as shown in [Figure 7](#) and [8](#)) does not automatically imply that their workers did not reallocate to more productive firms (at home or in Germany).³¹ For instance, [Mense-Petermann et al. \(2022\)](#) document that the main German meat producer began employing some workers, who had previously been posted, under German employment contracts after the 2014 reform.

5 Gravity Estimation

This section presents results based on a theory-consistent estimation of the gravity model for cross-border labor service trade, exploiting all sources of variation in wages, payroll taxes and minimum wages in 25 member states over the period 2009-2018. The model says that posting flows are described by the following expression:

$$S_{ijt} = \exp \{ -\theta \log(c_{ijt}) - \theta \log(m_{ij}) - \log(\Phi_{jt} S_{jt}) + \theta \ln T_i \} \quad (6)$$

where c_{ijt} is the total hourly wage cost employers must pay to export physical services from i to j in year t , m_{ijt} are bilateral trade costs that can vary over time or not, and $\Phi_{jt} S_{jt}$ is the multilateral resistance term described previously. Taking this equation to the data means that I will estimate a specification of the form:

$$S_{ijt} = \exp \{ -\theta \log c_{ijt} + \gamma_{ij} + \gamma_{it} + \gamma_{jt} + \varepsilon_{ijt} \} \quad (7)$$

where γ_{ij} , γ_{jt} and γ_{it} are fixed-effects defined respectively at the origin-destination,

³¹Although the much bigger change in minimum wages for foreign workers could lead to different total employment responses, see [Alfaro-Ureña et al. \(2021\)](#) for a discussion.

destination-year and origin-year level. The structural parameter θ is primarily identified by two types of variation. First, *origin-specific* payroll tax reforms *within* receiving countries: workers sent from different countries are subject to different taxes in the same receiving country and those taxes vary over time. Second, *origin-destination* minimum wage variation: workers posted from different countries are affected differentially by destination-level changes in minimum wages because of different initial wage levels.³²

I estimate Equation (6) at the country-level (one observation by destination-origin-year cell): hence I do not adjust c_{ijt} for the sector \times year preferential schemes studied in the country-specific case studies. For instance, destination-based payroll tax rates specific to temporary employment agencies in border regions are not reflected in the nationwide measure of τ_{it} in Luxembourg. Similarly, the German minimum wage reform in 2015 will be reflected in my nationwide measure of \bar{w}_{jt} but not the sectoral-level minimum wages binding in the construction before that year.

This has two implications for interpreting the theory-based estimates of θ . First, due to measurement error, those elasticities will be biased towards zero and will be lower bounds for the reduced-form estimates presented in Table 1. Second, the gravity estimation acts as an “out of sample” and generalization exercise for the country case-studies. While exploiting different variation (all nationwide tax and minimum wage reforms), and different measures of bilateral posting flows (aggregated at the EU level for 25 countries), I obtain an estimate of θ that allows me to predict posting responses to the country-specific reforms studied before.

I present the estimates in Table 2. All specifications include destination-origin fixed effects (filtering-out bilateral migration costs m_{ij}) and a free posting agreement dummy to account for variation in posting regulations over time.³³ As demonstrated by [Anderson and Van Wincoop \(2003\)](#), failure to account for the multilateral resistance term can lead to bias in estimates of gravity coefficients. Therefore, all specifications include destination-year fixed effects (filtering-out $\Phi_{jt}S_{jt}$) that account for a country’s “remoteness” in terms

³²For instance, consider three firms located in three different countries supplying services to clients in j . The first firm pays $\bar{w}_{jt} + \tau_{1t} \cdot w_{1t}$, the second pays $\bar{w}_{jt} + \tau_{2t} \cdot w_{2t}$ and the third pays $w_{3t} + \tau_{3t} \cdot w_{3t}$ (because $w_{3t} > \bar{w}_{jt}$). Any reform in \bar{w}_{jt} affects the labor cost of those three firms differentially.

³³That variation is summarized in Table B.3.

of service trade. 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 (but I will show robustness to alternative inference procedures).

Column (1) of Table 2 presents the basic specification with pair fixed-effects and destination-year fixed effects, exploiting variation *within* destination country and year in the labor cost of different exporting countries. The fixed effects control for unobserved time-varying destination characteristics, filtering out all destination-specific shocks that would be correlated with demand for posting services in country j . 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 (6) should reflect the differential use of domestic versus foreign in-person services. The specification presented in Column (1) thus also includes services supplied domestically (S_{jtt}) in the estimation sample. The estimated elasticity is substantial but below unity, with a point estimate of $-.75(.2)$. This elasticity is a bit larger than the steady-state correlation presented in Figure 3 but lower than reduced-form estimates presented in Table 1.

Column (2) repeats the specification from Column (1) but removing internal flows from the estimation sample. The estimates remain stable with a coefficient of $-.80(.2)$ and do not appear to be sensitive to the inclusion of domestic supply of physical services.

Column (3) repeats the specification from Column (2) but uses a Poisson pseudo-maximum likelihood (PPML) estimator. This accounts for the fact that with OLS the log-linearization of the multiplicative gravity equation can be biased by zero flows and heteroskedastic error terms (Silva and Tenreyro, 2006). Estimates with log-linear OLS and PPML are close. This is unsurprising because there are limited zero flows in the dataset due to the absence of a reporting threshold for posting contracts. The estimated elasticity is $-1.2(.1)$.

Next, I estimate a Poisson regression using trade shares λ_{ijt} instead of levels S_{ijt} as my outcome variable, following Eaton, Kortum and Sotelo (2012).³⁴ This strategy avoids biasing estimates of the structural parameters towards large countries. This estimator is validated by Monte-Carlo simulations shown in Head and Mayer (2014). The implied

³⁴Those shares sum to one at the importing country level and are defined in the theoretical section.

trade elasticity displayed in column (4) is -2.1(.4) and is now closer to the reduced-form estimates presented in Table 1.

So far, the identification has used exogenous variation in origin-specific wage costs which differentially affect workers sent to the same destination country, controlling for all changes in demand and supply in the importing country.³⁵ One potential source of endogeneity lies in unobserved shocks occurring in the same year as a tax reform in the origin country. For instance, a payroll tax reform could be implemented jointly with other policies that boost exporting firms' productivity and make them more competitive, leading my estimates to be biased upwards. The specification in Column (5) introduces a origin-year fixed effect and is thus comparable to estimates reported in Figure 5 and Figure 8. This control ensures that even if nationwide reforms are endogenous, this does not necessarily pose a threat to identification. In this specification, the only source of variation left comes from nationwide destination-level minimum wage reforms that affect each exporting country differentially (because of different previous gross wage levels). The estimated coefficient becomes smaller than the coefficient in Column (4), suggesting that general equilibrium effects do occur and may bias the estimates upwards. But the estimated elasticity remains large and statistically significant, with a point estimate of -1.2 (.2), which is extremely close to the reduced-form estimate in Figure 7 exploiting similar bilateral variation from minimum wage reforms. Note that re-estimating this specification by omitting posting flows to Germany yields a similar estimated coefficient of -1.1(.37). Hence the elasticity in Table 2, Column (5), is not merely duplicating Figure 7 with a different dataset. Rather, this result shows that exploiting conceptually similar bilateral variation in wage costs gives similar estimates of θ in the case study and in the gravity estimation pooling all country-pairs. Finally, adding internal flows to the preferred specification in Column (6) yields a similar a point estimate of -1.3(.22).³⁶

³⁵In their survey of the literature, Kleven et al. (2020) emphasize that this is usually considered to be the best available source of variation to study how international movements of labor respond to tax reforms. For instance, Kleven et al. (2014) exploit within-destination differences in tax rates applied to foreigners and domestics. Thanks to my setting, I can exploit an additional dimension: labor costs do not only vary by destination, but also by origin (because of different tax bases and different degrees to which the minimum wage binds in destination countries).

³⁶Note however that this poses some non-convergence challenges when performing the PPML estimation that uses a regressor in levels, rather than logs, since S_{jj} is disproportionately larger than S_{ij} .

I perform additional tests to gauge the robustness of the results. Column (1) of Table A.1 shows the preferred coefficient 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 elasticity remains precisely estimated and is statistically significant at the one percent level. Column (3) investigates potential heterogeneities by restricting the estimation to the Eurozone only, and shows again similar results. Column (4) shows unchanged estimates after I account for posting flows with multiple destination countries in my measure of bilateral posting flows.

Overall, the estimates presented in Table 2 confirm the large causal effects of labor market regulations on trade in physical services within EU countries. The estimates from the gravity model are larger than the steady-state correlations and at the lower end of the reduced-form elasticities from the case studies. Using the more conservative coefficient in Column (5) means that a 1% increase in firms' wage costs when exporting physical services from i to j results in a corresponding 1.2% reduction in posting flows from i to j .

Because my gravity estimation is an empirical application of widely used trade models (e.g Eaton and Kortum, 2002) and relies on similar estimators and fixed effects than most other applications (Head and Mayer, 2014), I can benchmark my estimates to those obtained in different contexts. Even though non-tariff trade barriers represent more than 70% of all trade barriers in the world (Looi Kee et al., 2009; Niu et al., 2018), it is hard to compare the magnitude of trade responses to (i) non-monetary regulations and (ii) ad-valorem tariffs. My setting is different because I can infer the euro-equivalent change in wage costs that follows a change in labor regulations in the posting program. My estimates are thus directly comparable to trade elasticities estimated in other contexts. The trade elasticities for physical services presented in Table 2 are smaller than the trade elasticity for goods, which is usually estimated around 5 (Head and Mayer, 2014).³⁷ Given the weight of services in modern economies and the lack of estimates for the trade elasticity in those sectors (Francois and Hoekman, 2010), these numbers can be useful for calibrating

³⁷The R-squared is 0.96, suggesting that a simple trade model performs well in explaining the geography of trade in physical services.

quantitative models of service trade.

The estimation structure provided by the gravity model also enables me to test for other potential margins of response to posting-specific labor regulations. In Table A.2, I repeat the baseline estimation presented in Table 2 but I replace bilateral trade in physical services with bilateral trade in goods.³⁸ This is not a placebo test, because countries could substitute imports of posting services with imports of goods, although many posting services are not “tradable.” But for some activities, such as meat processing, countries could import more goods (e.g. meat in this example) as the cost to import labor services increases due to posting-specific regulations. Posting-specific wage costs have a positive effect on bilateral trade in goods, in contrast to their negative effect on trade in services. This is evidence that the baseline estimates do not capture responses to unobserved shocks that would affect less labor-intensive exports in a similar way. Rather, the positive sign suggests a small substitution effect between exports of physical services and exports of goods in response to a tightening in posting-specific labor regulations.

Another key advantage of my setting is that I can compare short- and long-run elasticities obtained within the same estimation framework. My difference-in-differences analysis showed clear evidence of the dynamic adjustment of trade flows to changes in labor regulations, with responses growing over time. In contrast, the year-to-year (short-run) posting responses to changes in wage costs is smaller. These dynamics are very similar to those recently documented by [Boehm, Levchenko and Pandalai-Nayar \(2023\)](#) for trade in goods, suggesting that it also takes several years for the cross-border supply of physical services to adjust to payroll tax and minimum wage reforms. The difference-in-differences designs thus usefully complement standard gravity approaches, not only because they provide credible tests for identification (e.g. inspection of pre-trends) but also because they transparently show the dynamic adjustment of trade flows to permanent changes in labor market regulations. This finding is also consistent with the public finance literature that shows dynamic employment responses to payroll tax cuts (e.g. in [Saez, Schoefer and Seim,](#)

³⁸Only firms exporting posting services must match the minimum legal wage in the importing country; manufacturing exporters are not affected by this prevailing wage rule. Origin-specific payroll tax reforms affect both exporters of posting services and goods, although firms exporting labor-intensive services should be more exposed to those reforms if labor costs account for a larger share of their total unit cost.

2019; Guo, 2023) which goes against the belief that fiscal devaluations may only boost exports in the short-run (Farhi, Gopinath and Itskhoki, 2014).

6 Policy Counterfactuals and Distributional Implications

In this section, I use my estimates to perform back of the envelope computations of the effects of several policy proposals on posting flows, tax revenues and posted workers' wages. I also outline the political implications of international competition based on labor standards in the context of posting.

The Bolkestein Directive The Bolkestein Directive, officially known as the "Directive on services in the internal market, " was named after Frits Bolkestein, the European Commission Commissioner for the Internal Market who proposed it in 2005. This proposal emerged after concerns of protectionism in posting became salient following the accession of 10 Eastern European countries. Those countries felt disproportionately penalized by the regulatory framework of the posting policy and the enforcement of some domestic standards to foreign firms. The Bolkestein directive thus proposed to enforce the "country of origin principle," which would have allowed firms to fully operate under the laws and regulations of their home country when providing services in other EU countries, instead of having to comply with the home country's minimum wage.

The "Bolkestein Directive" became a highly controversial topic in Europe, and sparked a wave of protests right after the introduction of the proposal at the EU Parliament in March 2005. Critics of the directive, including trade unions and left-wing political parties, argued that it would lead to a "social dumping, " as service providers from countries with lower standards would be able to offer their services without having to comply with the host country's regulations. The protests against the Bolkestein directive represented one of the first instances of coordinated demonstrations across multiple EU countries. Seizing upon the concerns of unfair competition generated by the law, Philippe de Villiers, a French politician with strong anti EU views, popularized the term "Polish plumber" on March 15, 2005, in an op-ed that gained widespread attention in Europe.

In France, the polemic intervened just in the middle of the campaign for the adoption of a European constitutional treaty, that aimed to deepen European integration. Figure 9, Panel A, shows that the French public debate interest for the Bolkestein Directive peaked right after the introduction of the proposal at the EU Parliament and De Villiers's op-ed. The controversy sparked by the directive became so central and controversial in the French public debate on the referendum that the president Jacques Chirac had to call for an immediate withdrawal of a proposal deemed "unacceptable" by France.

Panel B shows the evolution of voting polls to adopt the EU constitution in France. Support for the project dropped dramatically in the days following the introduction of the Bolkestein Directive in the EU Parliament, and the start of the "polish plumber" polemic about social dumping in services. Support for EU integration then remained permanently lower, and the project was rejected. This figure suggests that the fears of foreign competition based on different labor norms triggered by the Bolkestein Directive played a key role in the rejection of the EU project by French voters, a conjecture that has previously been made by political scientists (Perrineau, 2005). Following the rejection of the European treaty by French voters, the Bolkestein proposal was retracted and later reintroduced without the "country of origin principle" that led to the political backlash.

My estimates allow me to predict what would have been the implications of this proposal on the geography of posting flows in Europe. I predict the changes in posting flows triggered by the predicted changes in labor costs \hat{c}_{ij} by combining my estimates of θ with the relationship in Equation (6).³⁹ My lower bound elasticity is the coefficient in column (5) of Table 2 and my upper bound elasticity is the average of this estimate and the three reduced-form elasticities in Table 1. The results are presented in Table 3, Panel A.

The Bolkestein directive would have triggered a massive drop in labor costs for firms located in low-wage countries supplying services in high-wage countries. Panel A shows that, as a result, exports of labor services from Eastern European countries would have doubled (in the upper bound). Mechanically, the expanded market shares for low-wage countries would also double tax revenues collected by origin countries on workers posted

³⁹Formally, I predict $\hat{S}_{ij} = S_{ij} \exp[-\theta(\log \hat{c}_{ij} - \log c_{ij})]$. This only captures first-order effects of changes in labor costs on bilateral posting flows and ignores general equilibrium or reallocation effects.

abroad.⁴⁰ The counterpart of this aggregate boost in exports is a 16% decrease of posted workers' average wages, since they lose their right to minimum wages in destination countries.⁴¹ In contrast, the impact would have been minimal for firms located in older member states that are mostly not constrained by the minimum wage rule (except for firms located in Southern Europe). These numbers confirm that the Bolkestein directive would have raised competition in high-wage countries from countries with lower wage floors. The withdrawal of the law thus also eliminated a source of revenue and employment for Eastern and Southern European countries, which explains their initial support to the Directive.

Tax Cooperation Panel B investigates an alternative proposal that focuses on payroll taxes instead. To neutralize the tax differentials allowed by posting, some political leaders in old member states have advocated to shift to a destination-based taxation system. The basic proposal would enable exporting countries to keep collecting labor taxes on posted workers by (i) applying destination-specific payroll tax rates and (ii) including the posting allowance in the tax base.⁴² This reform would decrease postings from Eastern European countries by at least 10% and at most 25%. The reform would also slightly decrease exports from older member states since tax rates differ even when countries have similar wage levels. While the reform would decrease the net volume of postings in the EU, total taxes collected on posted workers would nevertheless increase, even when considering an upper bound elasticity (with respect to total wage costs) of ≈ -3.7 .⁴³

⁴⁰Recall the posting allowance is not included in the payroll tax basis and hence removing it does not affect tax revenues in exporting countries.

⁴¹Of course, if the average equilibrium wage (without the posting allowance) for posted workers is different than the equilibrium wage in the origin country, then the expansion of posting exports would increase the wages for newly posted workers, and the net effect is unclear.

⁴²Some policymakers have also proposed that destination countries could collect taxes on posted workers working within their territory, see [Rocca \(2020\)](#) for a detailed proposal.

⁴³This is because a 1% increase in payroll tax rates on average implies much less than 1% increase in total wage cost. Of course, with sufficiently large θ (for instance the maximum reduced-form estimate in Table 1), the reform decreases overall tax revenues on posted workers.

7 Concluding Remarks: the “Polish Plumber” Parable

In a book written in the late 1990s, Has globalization gone too far?, Dani Rodrik illustrated the importance of considering social standards in the process of trade liberalization with a simple “parable.” In the first scenario, Honduran workers produce clothing in Honduras, following the labor laws and standards of their home country. In the second scenario, Honduran workers temporarily travel to the United States to work in the clothing industry but are still governed by Honduras’ labor laws. From an economic standpoint, these two configurations are equivalent: the well-being of displaced US workers, Honduran workers and firms’ shareholders are exactly the same. Hence, anyone basing their view on pure economic outcomes should support both policies. But, as Rodrik puts it, *“the vast majority of economists who have no difficulty with the outsourcing example would also accept that it is not good public policy to relax labor standards for migrant workers.”*

While Rodrik’s parable was initially conceived as an extreme thought experiment to highlight the complex political considerations in the trade liberalization process, the EU posting policy has effectively brought this example to life in the real world. Many economic stakeholders shared Rodrik’s view that a commitment to free trade within the single market contradicted the enforcement of domestic standards on foreign firms in the posting policy, and proposed removing those regulations in 2005. Today, the debate surrounding the Bolkestein directive proposal is still viewed as the pivotal moment that marked the rejection of a globalization process based on competition in labor standards (Cagé and Piketty, 2023). Similar to Rodrik’s allegory of Honduran migrants, the “Polish plumber” case-study illustrates why the question of trade liberalization is hard to address separately from that of social convergence.

My analysis focused on how social standards shape countries’ comparative advantage and market shares in labor-intensive sectors. I showed that labor market regulations are an important driver of trade in labor services in Europe. Of course, imposing domestic standards on foreign firms has many potential costs and benefits for customers, firms and workers. To fully quantify this, one must consider factors such as price effects on consumers, labor reallocation between origin and destination countries, and the general

equilibrium impact of taxes and labor regulations on wages and trade balances. A comprehensive welfare analysis falls outside the scope of this paper but provides a fruitful avenue for future research.

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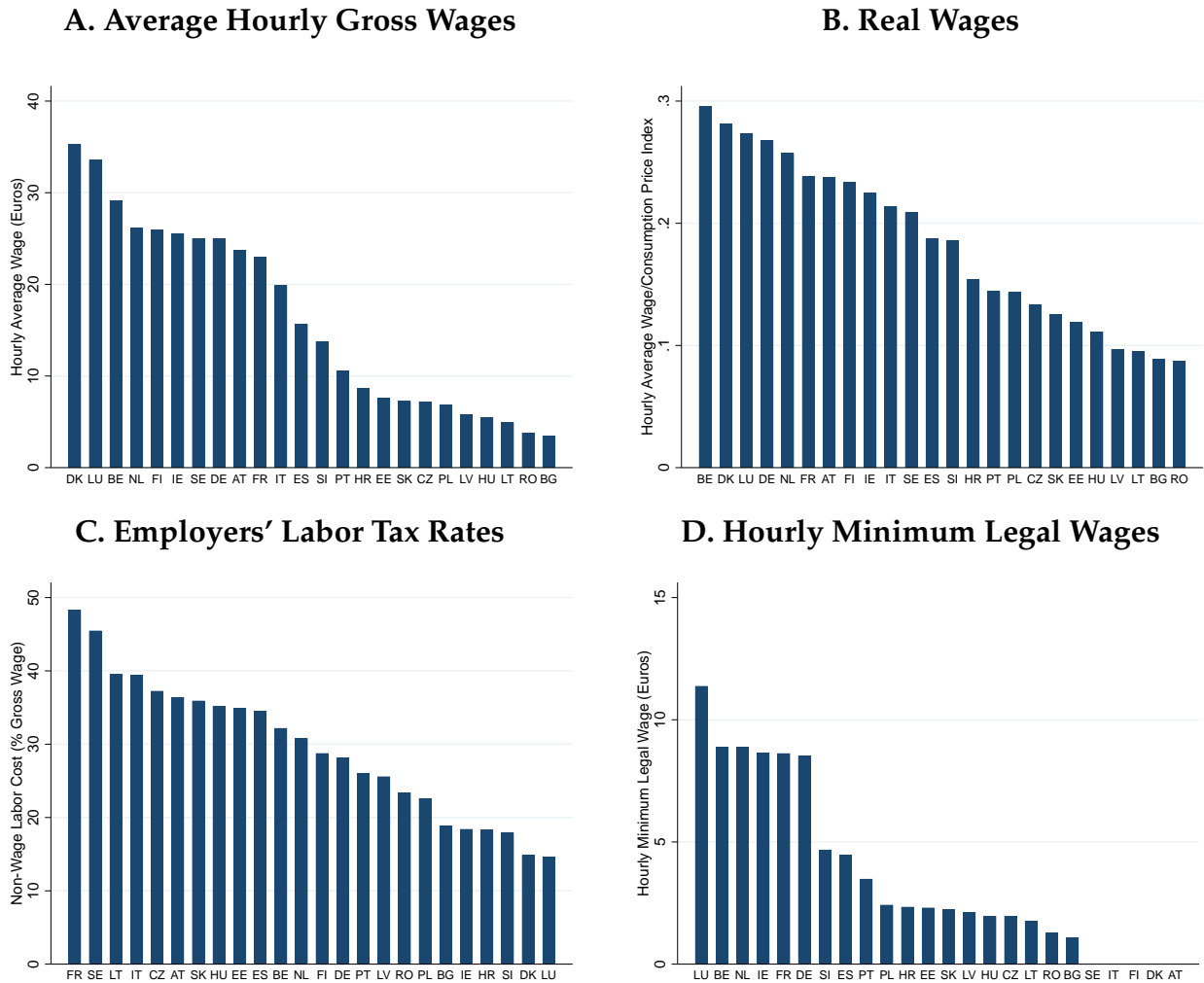
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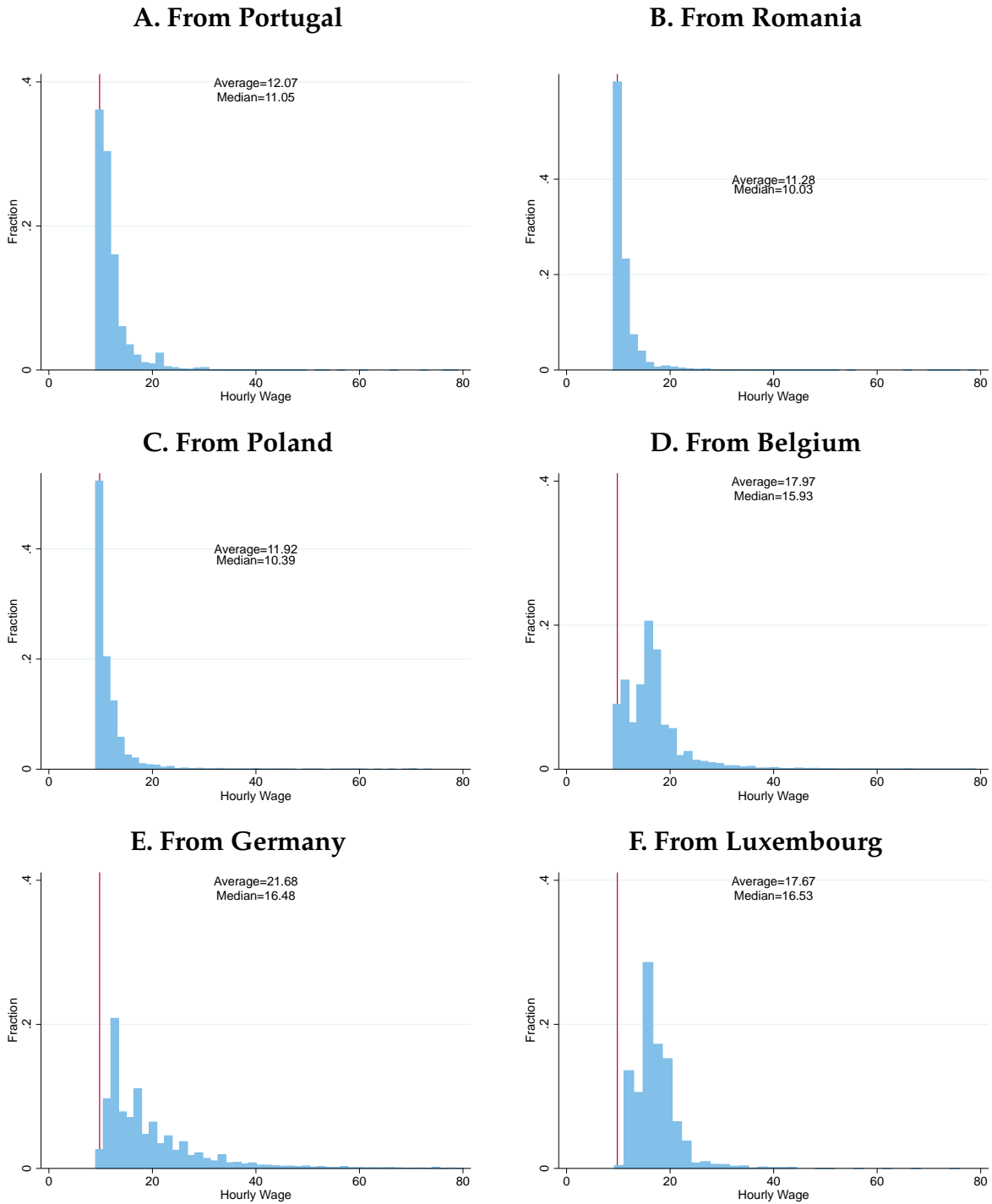
8 Figures And Tables

Figure 1: Wages, Payroll Taxes and Minimum Wages in the European Union



Notes: This figure shows different components of hourly labor costs in Europe in 2015, using data collected from Eurostat. Panel A plots average nominal hourly gross wages paid in the country. Panel B divides gross hourly wages by a harmonized consumption price index to account for differences in prices across EU countries. Panel C plots employers' effective payroll tax rates, computed as social security contributions and other labor taxes net of subsidies, in percent of gross wages paid to employees. Panel D plots nationwide statutory minimum legal wages.

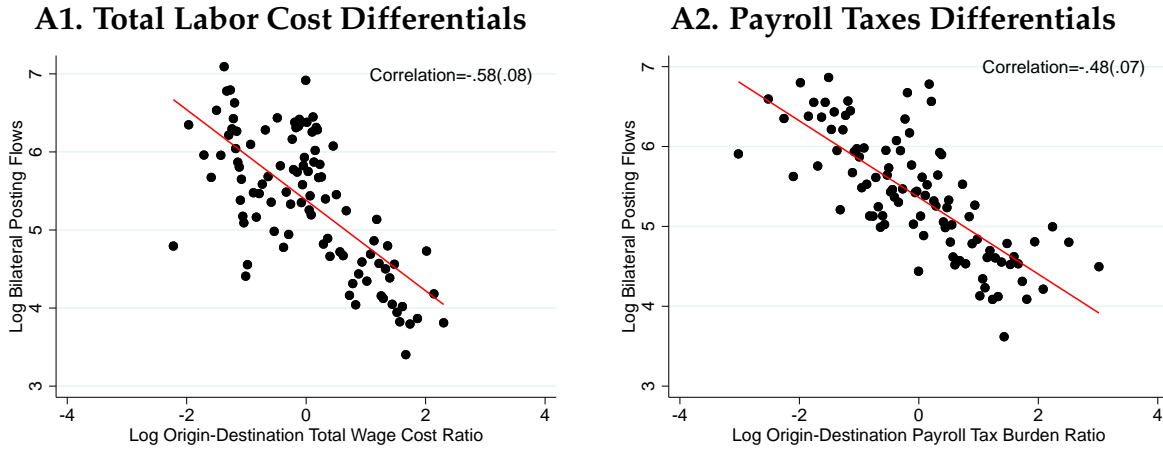
Figure 2: Bindingness of French Minimum Wage by Origin of Exporting Firms



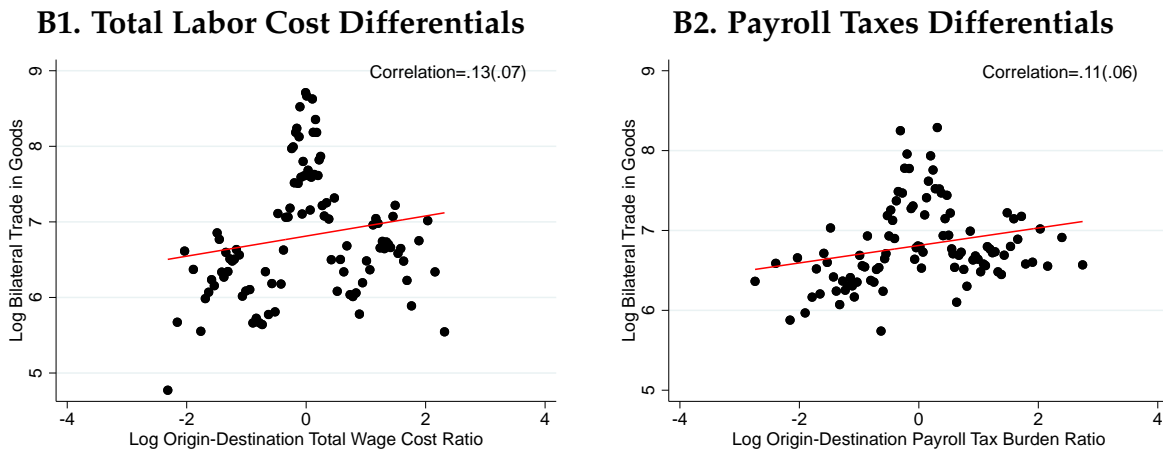
Notes: This figure illustrates the degree to which the domestic minimum wage of an importing country (France) binds for exporting firms located in different origin countries. Each panel plots the distribution of hourly wages paid to workers employed by exporting firms in each of those countries and supplying physical services within France territory in 2018. Per EU law, exporting firms must comply with the French minimum legal wage during the posting contract. The French minimum legal wage that year is depicted by the vertical red line. Each figure displays the median and average nominal hourly wage paid by firms located in each of those countries when supplying services in France.

Figure 3: Steady-State Correlation Between Trade Flows and Labor Cost Differentials

A. Trade in Physical Services (Labor-Intensive)



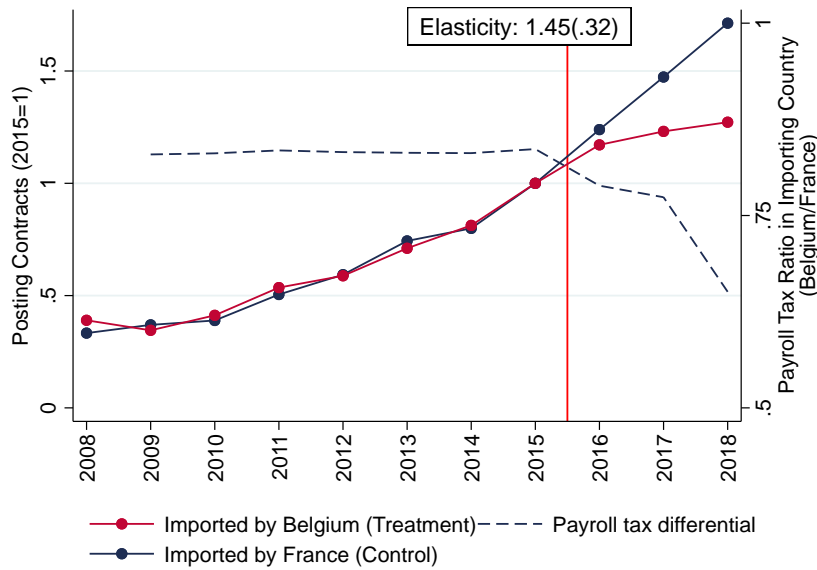
B. Trade in Goods (Less Labor-Intensive)



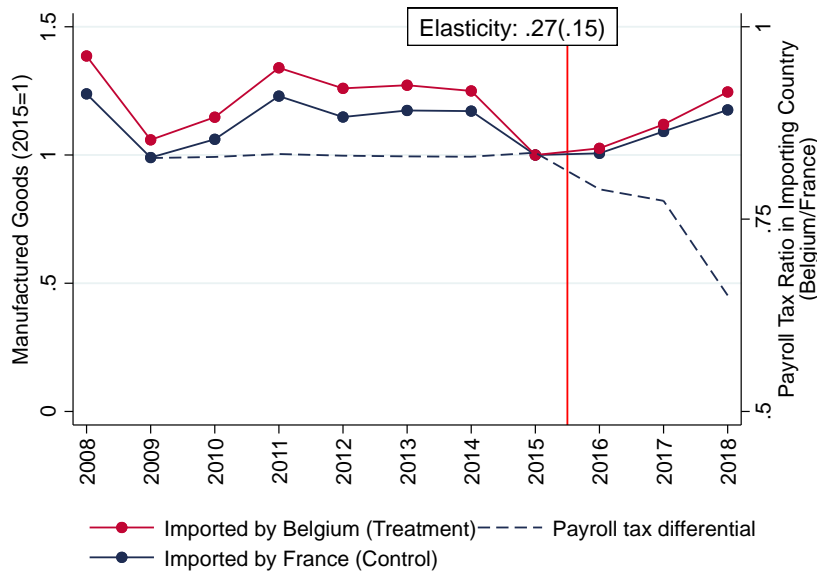
Notes: This figure depicts the relationship between the log of bilateral trade flows and the log of labor cost differentials, for a given country-pair during the 2009-2018 period. The top panel uses bilateral posting flows (physical services) measured by number of workers exported from one country to another. The bottom panel uses bilateral trade in goods (in values) from [Head and Mayer \(2014\)](#). Panel A1 measures employers' hourly labor cost differentials between domestic and posted workers, after accounting for the specific payroll tax rates and minimum wages that apply to foreign firms. Panel A2 focuses on differences in payroll tax burden, that is to say the amount paid for social security contributions and other labor taxes for one hour of labor. The red line depicts the best linear fit using a univariate regression. The correlation between log bilateral trade flows and the log labor cost differentials is displayed in each figure with standard errors clustered at the country-pair level in parentheses.

Figure 4: Effect of Cutting Payroll Taxes in Belgium on Imports

A. Imports of Physical Services Differentially Decreased



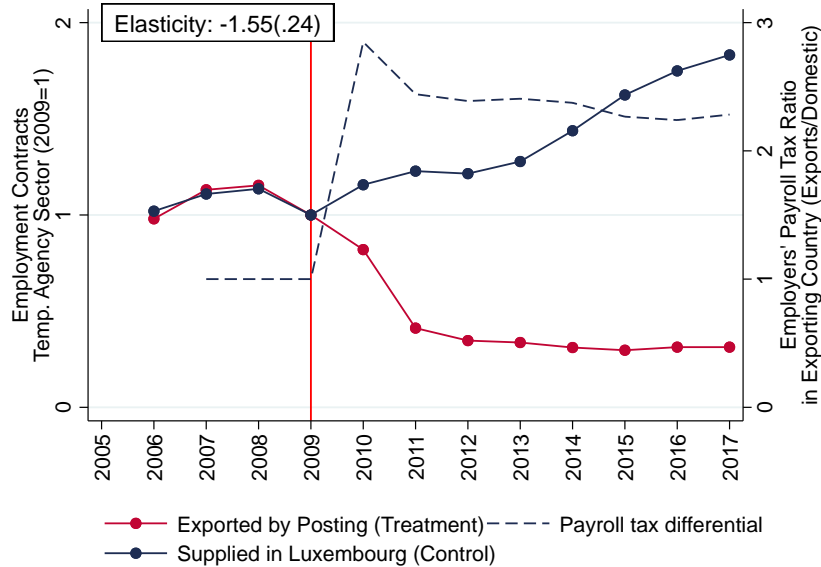
B. No Effects on Imports of Goods



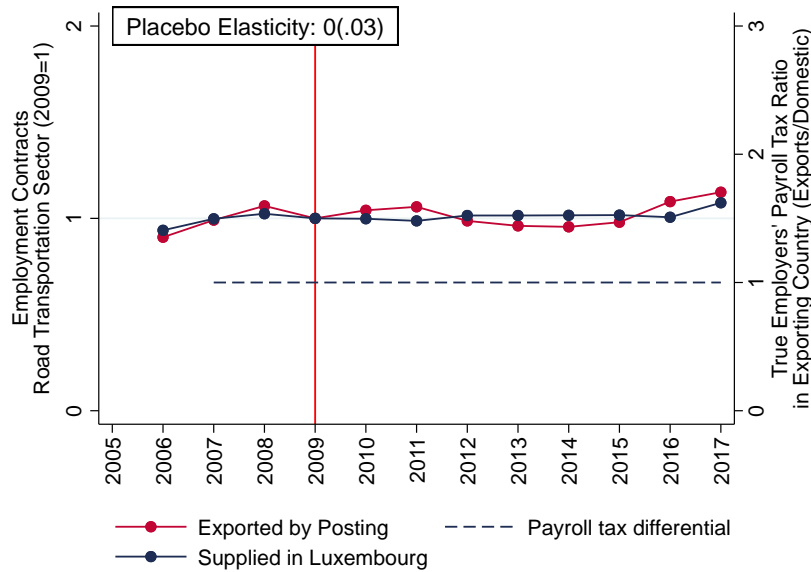
Notes: This figure shows the effects of a budget-neutral 2015 reform that decreased Belgian employers' social security contributions by 8 percentage points, on imports of labor services (Panel A) and imports of manufacturing goods (Panel B). The dashed line (and left y-axis) shows the evolution of the 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.

Figure 5: Effect of Imposing Destination-Based Taxes on Luxembourgish Exporters

A. Exports of Posting Services Dropped in the Exposed Sector

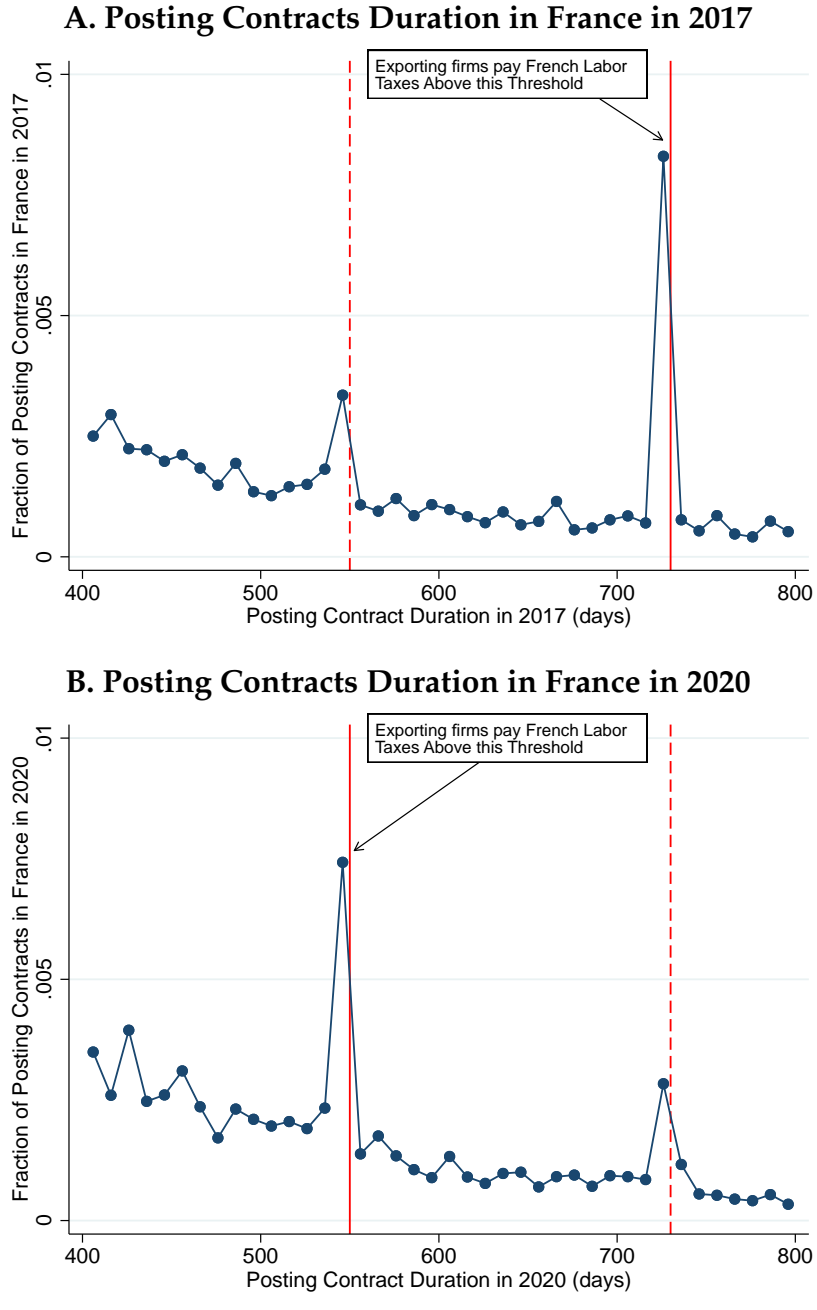


B. No Differential Evolution in the Sheltered Sector



Notes: This figure shows the effects of a EU regulation implemented in May 2010 that imposed destination-based payroll taxation on temporary employment agencies located in border regions posting workers in neighboring countries. The dashed line (and y-axis) shows the evolution of the payroll tax rate ratio between exporters (treated) and firms that sell domestically (control). The top panel shows exports (treated, red series) versus domestic (control, blue series) contracts (measured in unit of workers) of temporary employment agencies in Luxembourg, before and after the reform (vertical red line). The bottom shows the same differential evolution for the road transportation sector, that was sheltered from the reform for 10 years due to a “transitory” sector-specific exemptions. All series are normalized to one in the pre-reform year. The elasticity reported in the figure is computed with respect to the change in statutory payroll tax rate.

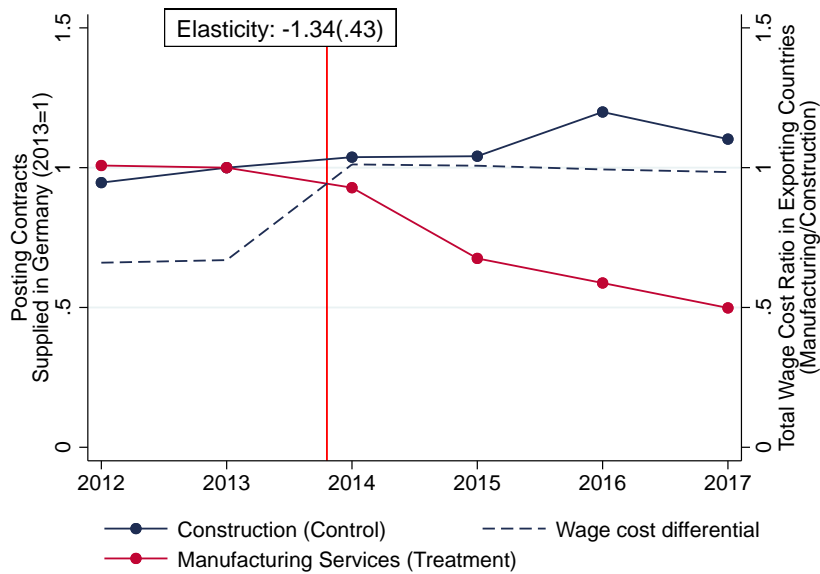
Figure 6: Exporting Firms Bunch to Avoid French Labor Taxes



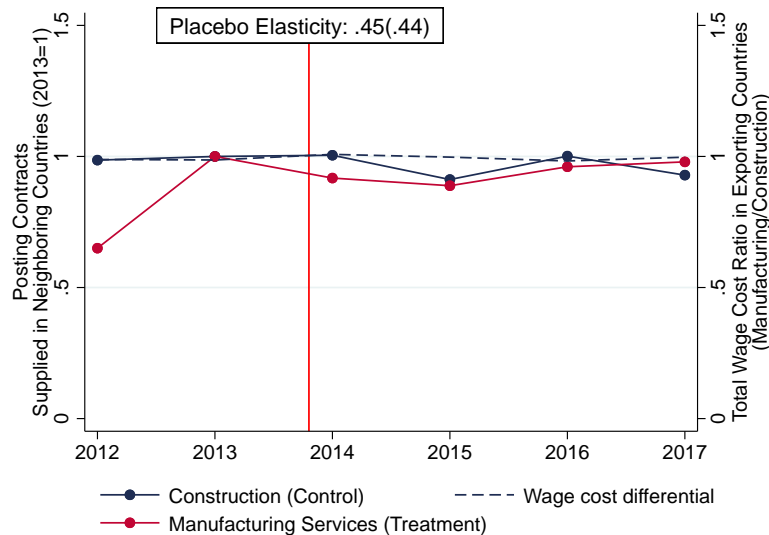
Notes: This figure shows the distribution of the duration of posting contracts (grouped by bins of 10 days) performed in France, the country with the highest payroll tax rate in the EU. The vertical red line in each figure depicts the regulatory thresholds for destination-based taxation set by the EU. 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.

Figure 7: Effect of Imposing German Minimum Wage on Exporting Firms

A. Exports of Posting Services to Germany Dropped in the Treated Sector



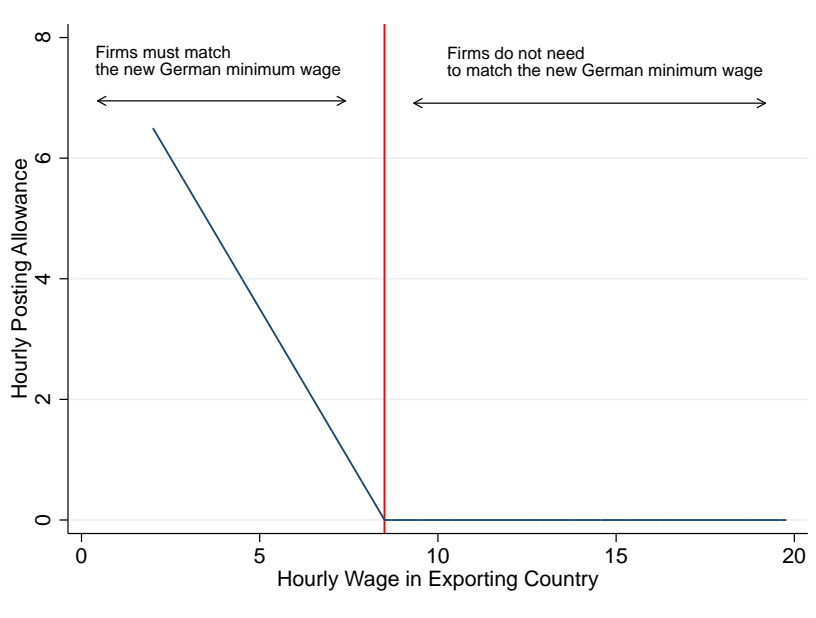
B. No Differential Evolution in Neighboring Countries



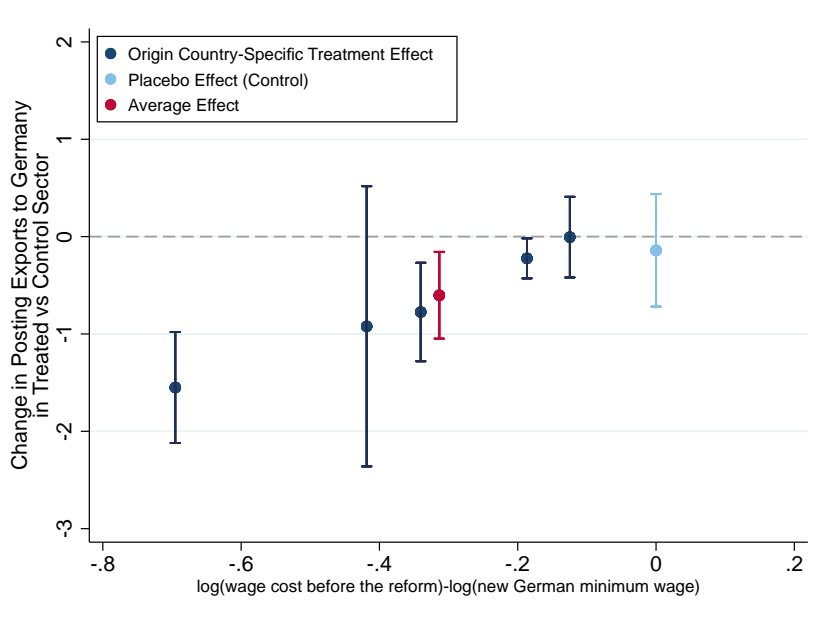
Notes: This figure shows posting responses to a minimum wage reform in Germany. Before 2014, only foreign firms operating in the construction sector were subject to the German (sectoral) minimum wage. Other foreign firms became liable to the German minimum wage in August 2014 (when operating in meat processing industry) or 2015 (in all other manufacturing services). The dashed line (y-axis) shows the evolution of labor costs for firms supplying manufacturing services (treatment) versus construction services (control) in Germany. The top panel shows the evolution of exports of manufacturing services (treatment, red series) and construction services (control, blue series) to Germany, before and after foreign firms become liable to the German minimum wage in the treated sector. The bottom panel shows the same differential evolution in Germany's neighboring countries where minimum wage requirements for foreign firms do not vary across sectors and stayed constant during the period. All series are normalized to one in the pre-reform year 2013.

Figure 8: Heterogeneous Effects by Bindingness of German New Minimum Wage

A. Firms in Low-Wage Exporting Countries Faced Larger Additional Costs



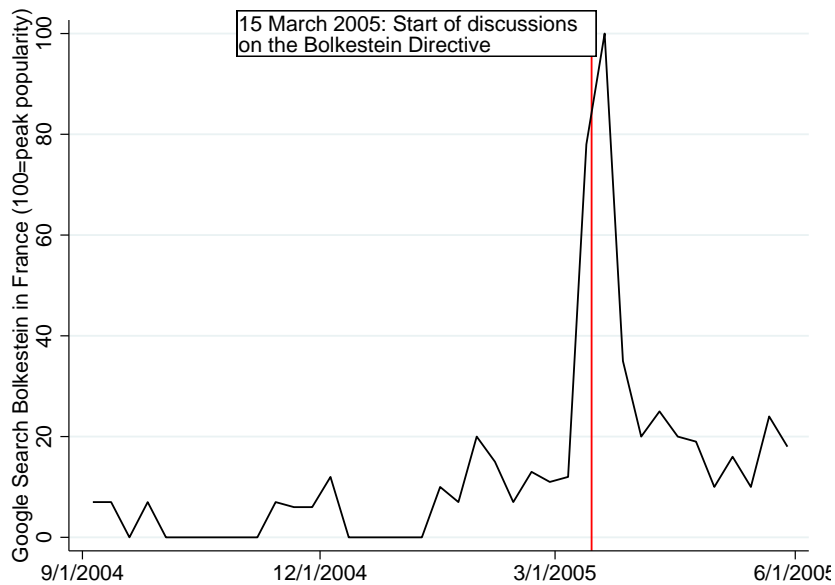
B. Posting Responses by Bindingness of the Reform



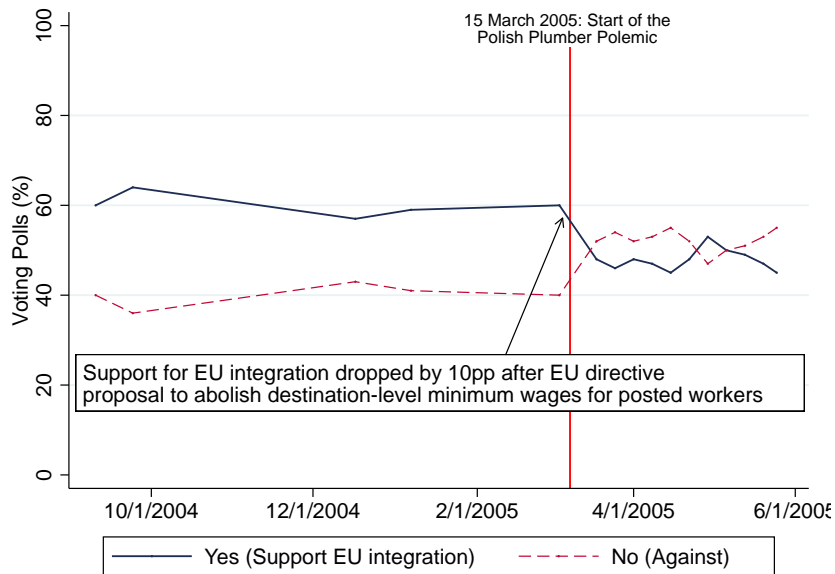
Notes: Panel A shows the kinked relationship between the average wage in the exporting country and the additional wage cost that foreign firms must pay to supply services in Germany in the treated sectors after the 2014-2015 reform. Panel B shows the treatment effect (and 95% confidence intervals) of the German minimum wage reform on exports of posting services to Germany in the treated sector, estimated separately for each exporting country. The blue coefficient is the estimated treatment effect for the exporting country with zero direct exposure to the reform, Luxembourg (because its minimum wage was above the novel German minimum wage). The pink coefficient is the average treatment effect estimated for all exporting countries.

Figure 9: Threats of Social Dumping and Political Support for EU Integration

A. Salience of the “Bolkestein Directive” in French Public Debate



B. Support for EU Integration in France after “Polish Plumber” Polemic



Notes: The Figure describes the effects of the “Bolkestein directive,” that aimed to lower social standards applied to foreign firms engaged in the posting program, on support for EU integration in France. The top panel shows google searches for the Bolkestein directive in France. The bottom panel shows the evolution of voting polls in the French referendum for the adoption of the EU constitution in 2005. The vertical red line refers to the introduction of the Bolkestein directive at the EU parliament.

Table 1: **Reduced-Form Estimates of Posting Responses to Payroll Tax and Minimum Wage Reforms**

Description	Elasticity w.r.t labor tax rate	Elasticity w.r.t labor cost	
	(1)	(2)	
<i>Panel A. Labor cost reform in importing countries</i>			
<u>A1. Belgian Tax Shift (2016)</u>			
Employers' social security contributions rate on all employees hired in Belgium was decreased from 33% to 25% starting at the beginning of 2016. DD estimation comparing imports of posting services in Belgium versus France.	Imports	1.44*** (.32)	3.78*** (.74)
	Exports	-2.83*** (1.3)	-7.1*** (2.1)
<i>Panel B. Labor cost reform for exporting countries</i>			
<u>B1. EU Regulation (2010)</u>			
A new regulation required that Luxembourgish firms pay payroll taxes in the destination country when posting temporary employment agency workers abroad after May 2010. DD estimation comparing services supplied abroad vs at home for firms located in Luxembourg. Placebo estimation for a sector sheltered from the reform.	Exports	-1.54*** (.24)	-8.51*** (1.39)
	Placebo Sector	-.00 (.02)	-.02 (.15)
<u>B3. German minimum wage reform (2014-15)</u>			
A minimum legal wage for foreign firms supplying physical services in Germany was introduced in the meat processing industry in August 2014, followed by a nationwide minimum legal wage for all sectors in 2015. Foreign firms supplying services in the construction sector were always subject to a German sectoral wage floor. DD estimation comparing exports of labor services to Germany in manufacturing vs construction sectors. Placebo estimation for an exporting country not binded by the new German minimum wage requirement.	Exports	-	-1.34** (.43)
	Placebo Origin	-	-.18 (.11)

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

Table 2: Elasticity of Trade in Physical Services to Policy-Induced Labor Cost Changes

Regressor: $\log(c_{ijt})$	(1)	(2)	(3)	(4)	(5)	(6)
Elasticity ($-\theta$)	-0.759*** (.20)	-0.80*** (.21)	-1.2*** (.12)	-2.1*** (.38)	-1.2*** (.20)	-1.3*** (.22)
Observations	5,539	5,291	5,532	5,532	5,532	5,767
Origin-Destination FE	Yes	Yes	Yes	Yes	Yes	Yes
Destination \times Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Origin \times Year FE	No	No	No	No	Yes	Yes
Estimator	OLS	OLS	PPML	MPPML	MPPML	MPPML
Internal Flows	Yes	No	No	No	No	Yes

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. This table summarizes coefficients estimated from Equation (6) on the full matrix of bilateral posting flows within the EU merged with data on employers' labor cost for each country pair for 2009-2018. 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 (6) (OLS estimation), in levels for specifications relying on the multiplicative form of Equation (6) following [Silva and Tenreyro \(2006\)](#) ("PPML" Poisson pseudo maximum likelihood estimator), and in shares λ_{ijt} following [Eaton et al. \(2012\)](#) ("MPPML" Poisson pseudo maximum likelihood estimator with trade shares as dependent variable). All specifications include destination-origin fixed effects, a dummy equal to one if posting regulations between country i and j changes at time t , and a destination-year fixed effect to control for the multilateral resistance term (Φ_{ijt}). Robust standard errors clustered at destination-year level are displayed in parentheses.

Table 3: Predicted Effects of EU Policy Proposals

	Exports of Labor Services		Taxes Collected on Posting Exports		Posted Workers' Average Wages	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound
<i>A. Bolkestein Directive</i>						
Eastern Europe	+23%	+108%	+23%	+108%		
Old Member States	+.3%	+1.3%	+.3%	+1.3%	-16%	-16%
<i>B. Destination-Based Taxation</i>						
Eastern Europe	-10%	-25%	+40%	+14%		
Old Member States	-1.2%	-2.2%	+7%	+6%		

Notes: This table summarizes the predicted effects of several EU policy proposals on the cross-border supply of physical of services in Europe. The lower bound effects are computed using the lower-bound estimate presented in column (5) of Table 2 while the upper bound uses the average of the lower bound and the three reduced-form elasticities presented in Table 1. I compute the implied change in bilateral wage costs that would be triggered by each of the proposed reform, and compute the implied change in bilateral posting flows. I then compute the corresponding change in tax revenues and posted workers' wages.