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Exporting and Labor Demand: Micro-level Evidence from Germany

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Abstract

It is widely believed that globalization affects the extent of employment and wage responses to economic shocks. To provide evidence for this, we analyze the effect of firms' exporting behavior on the elasticity of labor demand. Using rich, German administrative linked employer-employee panel data from 1996 to 2008, we explicitly control for self-selection into exporting and endogeneity concerns. In line with our theoretical model, we find that exporting at both the intensive and extensive margins significantly increases the (absolute value of the) unconditional own-wage labor demand elasticity. This is not only true for the average worker, but also for different skill groups. For the median firm, the elasticity is three-quarters higher when comparing exporting to non-exporting firms.

JEL-Code: F160, F660, J230.

Keywords: trade, export, labor demand, wage elasticity, administrative microdata.

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1 Introduction

The worldwide volume of exports has dramatically increased over recent decades. Whereas it has been shown that total benefits arising from international integration exceed losses, it is widely believed that globalization is accompanied by non-negligible negative consequences for workers. In his seminal work, Rodrik (1997) emphasizes that the extent of employment and wage responses to exogenous shocks increases with the level of globalization, as it raises the own-wage elasticity of labor demand. While (accelerating) international trade is rather a modern phenomenon, a theoretical mechanism explaining more elastic employment responses has long been known: one of the Hicks-Marshall laws of derived demand states that the unconditional own-wage elasticity of labor demand is higher, ceteris paribus, the higher the price elasticity of product demand (Hamermesh, 1993). By now, it has been shown that exporters are faced with destination-specific price elasticities of product demand, decreasing in per-capita income of the destination country (Markusen, 2013; Simonovska, 2013). Exporting firms in high-income countries are thus exposed to an overall more price elastic product demand than a comparable firm serving its domestic market only. Consequently, exporters should face a higher elasticity of labor demand.

Despite its importance, the effect of firms' export behavior on the elasticity of labor demand has not been explicitly investigated to date. In this paper, we explore this relationship theoretically and test it empirically using administrative linked employer-employee data for Germany. In terms of theory, we extend the model by Krishna et al. (2001) to allow for non-homothetic consumer preferences across countries, as in Markusen (2013). We show that (i) the implication of the Hicks-Marshall law of demand holds true in a model with firms exhibiting some price-setting power; and (ii) more elastic product demand for exporting than non-exporting firms transmits to higher own-wage elasticities for firms engaged in exporting.[1] Empirically, we use German administrative linked employer-employee data from 1996 to 2008 to test our model's predictions and explicitly analyze the effect of exporting at both

[1]When speaking of higher/larger or lower/smaller own-wage elasticities, we refer to absolute values throughout the paper. Hence, a higher wage elasticity means 'more negative' and thus de facto a wage elasticity with a lower value.

the extensive and intensive margins on the elasticity of labor demand, conditional and unconditional on output. Focusing on Germany holds particular interest in this context, given that the German economy is heavily reliant on exports, with its share on national GDP amounting to around 50% and with around one-quarter of all jobs depending on exporting (Yalcin and Zacher, 2011). Moreover, Germany is a high-income country with strong trade ties to low- and medium-income countries, thus making it an ideal candidate to test our theory.

In line with the theoretical predictions, we find that exporting at both the extensive and intensive margins has a positive effect on the absolute value of the unconditional own-wage elasticity of labor demand. When distinguishing labor among different skills and occupations, the pattern remains the same: while own-wage elasticities are generally higher for blue-collar than white-collar workers, exporting at both the extensive and intensive margins increases elasticities for all skill and collar groups. The results from our instrumental variables strategy show that the own-wage elasticity for the median exporting firm is -0.93, compared to -0.53 for non-exporting firms. We show that the results are not driven by selection into exporting. In line with our theoretical model, we further find that our results are not due to differences in the conditional elasticity of labor demand: elasticity estimates obtained from a structural model of cost minimization for given output levels are not statistically different for exporting and non-exporting firms. We take these results as suggestive evidence in favor of our proposed mechanism.

Overall, we add to the existing literature in three ways. First, we propose and verify an important mechanism of how exporting behavior – a central element of globalization – affects workers in the national labor market through higher labor demand elasticities. This channel is relevant for both theoretical models of international trade and policy analysis. For example, with the optimal minimum wage policy depending on the actual size of the (low-skilled) wage elasticity of labor demand (Lee and Saez (2012)), optimal policies might be different in trade-exposed and trade-sheltered sectors. Second, our study adds to the growing literature on the characteristics of exporting firms. It has been established that exporting firms considerably differ from those merely serving the domestic market (see Bernard et al.

(2007) for an overview). Nonetheless, it is important to establish a causal interpretation for these differences, as the decision to export is clearly endogenous (Bernard and Jensen, 1995; Clerides et al., 1998). Therefore, we explicitly address firms' selection into exporting and endogeneity concerns in our empirical analysis by applying a firm fixed effects, instrumental variables estimator in the spirit of Autor et al. (2013). Last, to the best of our knowledge, this is the first study on globalization and (the elasticity of) labor demand to use administrative linked employer-employee data. In recent decades, the literature has moved from using country-level to industry- and firm-level data. By using administrative linked employer-employee micro-level panel data, we are able to base our estimations on a rich set of establishments and their employees, thus analyzing differential effects of exporting on heterogeneous types of workers.

The remainder of this paper is structured as follows. Section 2 provides a discussion of the related literature, focusing on the effects of globalization on the elasticity of labor demand, as well as differences between exporting and non-exporting firms. We subsequently present the theoretical and empirical model in Section 3. Section 4 describes the dataset used in our analysis, whereas Section 5 provides descriptive evidence on plants' export behavior and firm characteristics. We present and discuss our empirical results in Section 6, placing special emphasis on the issue of endogeneity, before Section 7 concludes.

2 Related Literature

We combine two broad strands of related literature in our paper: studies analyzing (i) the effects of globalization on the elasticity of labor demand; and (ii) the differences between exporting and non-exporting firms, as well as the causal effect of exporting on firm behavior.

The analysis of different features of globalization and their corresponding effects on labor demand has attracted much attention in the literature. While Slaughter (2001) shows that (non-production) production labor has (not) become more elastic in manufacturing industries over time in the US, he finds only weak evidence for a direct effect of trade. Exploiting exogenous variation caused by trade liberalization reforms in low- and middle-income countries, several studies analyze the causal effect of trade liberalization on the elasticity of labor demand. Empirical evidence is mixed, with Krishna et al. (2001) as well as Fajnzylber and Maloney (2005) finding no significant empirical link between trade liberalization and the elasticity of labor demand, whereas Hasan et al. (2007) and Mitra and Shin (2012) show that trade liberalization reforms in Turkey and South Korea rendered the demand for labor more elastic.[2] Focusing on key aspects of globalization, several studies analyze the labor demand effects of firms' decision to outsource production processes, with the results suggesting that labor demand elasticities for (un-)skilled workers increase (decrease) (Hijzen et al., 2005; Senses, 2010; Hijzen and Swaim, 2010), albeit not in every country (Fajnzylber and Fernandez, 2009). Other studies investigate whether labor demand elasticities differ between multinational and domestic firms, yet no conclusive evidence has been found.[3]

Regarding the second strand of the literature, a variety of stylized facts has been established concerning the differences between exporting and non-exporting firms. Among others, exporting firms are larger in terms of both output and employment, more productive and pay higher wages than comparable non-exporting firms (see, for example, Bernard and Jensen, 1995; Bernard et al., 2007).[4] However, most differences do not stem from the mere act of exporting goods to foreign markets. For example, Clerides et al. (1998) and Bernard and Jensen (1999) show that only the most productive firms select into exporting, whereas no significant productivity gains occur after entering the export market.[5] It has been further es-

[2] Clearly, these studies are related to our work as trade liberalization increases firms' opportunities to sell their goods abroad, given that it increases competition through imports. However, the respective studies do not explicitly derive the effect of exporting on the elasticity of labor demand, but rather the overall effect of trade openness. Only Mitra and Shin (2012) analyze interaction effects of trade liberalization reforms, importing and exporting behavior to some extent.

[3] Evidence ranges from findings on higher absolute own-wage labor demand elasticities for multinational compared to domestic firms (Fabbri et al., 2003; Görg et al., 2009; Hakkala et al., 2010), no significant differences (Buch and Lipponer, 2010) to less elastic demand for labor by multinationals (Navaretti et al., 2003).

[4] Evidence for Germany is provided by Schank et al. (2007) who – controlling for observable and unobservable employee and firm characteristics – report wage premiums for workers employed in exporting firms, as well as Wagner (2007), who finds exporting firms to be more productive than non-exporting firms.

[5] Aw et al. (2000) and Delgado et al. (2002) find similar evidence; however, Van Biesebroeck

tablished that exporting firms' prices are destination-specific: Manova and Zhang (2012) show that firms charge higher prices for the same product in richer and less remote countries, among others. Simonovska (2013) relates country-specific prices to per-capita income differentials, with prices for the same product being higher in richer and less price elastic countries.

Related to our work, recent studies have investigated the relationship between the firm's export behavior and volatility in sales and employment. Using panel data on French manufacturing firms, Vannoorenberghe (2012) shows that firms' sales volatility increases with the export share. Nguyen and Schaur (2012) find similar evidence for Danish firms, yet show that the overall higher sales volatility for exporting rather than non-exporting firms is mainly driven by firms that do not continuously export. Focusing on employment, Kurz and Senses (2013) find a non-monotonic effect of exporting on the volatility of employment for US manufacturing firms.

We add to this evidence, as the own-wage elasticity of labor demand is an important proxy for future employment volatility and wage pressure. Moreover, by focusing on the elasticity of labor demand, we are further able to propose a new channel determining the effect of exporting on labor demand, while accounting for endogeneity concerns in the empirical analysis.

3 The theoretical and empirical model

In order to formally derive our hypothesis, we follow Krishna et al. (2001) and model firms' demand for labor in a monopolistic competitive product market setting with no strategic interactions between firms. Firm i is assumed to maximize profits by selling its product at the domestic market or by exporting it to foreign markets,

(2005) and De Loecker (2007) report productivity gains from exporting for Sub-Saharan African manufacturing firms and Slovenian firms during the transition from a plan to market economy, respectively.

facing a less than infinitely elastic overall product demand curve[6] of type:

$$p_i = \theta \overline{p} Q_i^{-\frac{1}{\epsilon_i}}. \tag{1}$$

The term p_i denotes the own price, $\overline{p}$ the average global product price, θ a scaling factor, Q_i the firm's output, and ϵ_i the price elasticity of demand. Following the theoretical model by Markusen (2013), we assume that consumer preferences are non-homothetic across countries, such that the price elasticity of product demand is country-specific and decreasing in per-capita income. Recent empirical evidence has indeed shown that the price elasticity of demand is decreasing with per-capita income and that (exporting) firms set higher prices in richer countries (Manova and Zhang, 2012; Simonovska, 2013). With different firms serving different countries to a different extent, this makes the elasticity of product demand firm-specific.

The production function is assumed to be Cobb–Douglas (in variable inputs), and is given by:

$$Q_i = \prod_{k=1}^{n} V_{ki}^{\alpha_k}, \tag{2}$$

where the term $V_{ki}^{\alpha_k}$ denotes the k^{th} input in production. Factor markets are assumed to be fully competitive, with the firm taking factor prices (w_k) as given. Partially differentiating profits with respect to the l^{th} input, labor, and equating it to zero, yields the following first order condition:

$$\theta \overline{p} Q_i^{1-\frac{1}{\epsilon_i}} \left(1 - \frac{1}{\epsilon_i}\right) \alpha_l V_{li}^{-1} = w_l. \tag{3}$$

Taking logs and reorganizing terms, this condition can be rewritten as:

$$\begin{aligned} \ln V_{li} = & -\frac{\ln\left(\theta\left(1-\frac{1}{\epsilon_i}\right)\alpha_l\right)}{\left[\alpha_l\left(1-\frac{1}{\epsilon_i}\right)-1\right]} + \frac{1}{\left[\alpha_l\left(1-\frac{1}{\epsilon_i}\right)-1\right]} \ln\left(\frac{w_l}{\overline{p}}\right) \\ & - \sum_{k \neq l} \frac{\alpha_k\left(1-\frac{1}{\epsilon_i}\right)}{\left[\alpha_l\left(1-\frac{1}{\epsilon_i}\right)-1\right]} \ln V_{ki}. \end{aligned} \tag{4}$$

[6] As noted by Krishna et al. (2001), this set-up approximates a setting with a large number of varieties in the product market, where each firm is an infinitesimal player but has some power concerning the pricing of its product.

Substituting the first order conditions for inputs $V_{k\neq l}$ into equation (4), the optimal labor demand function is given by means of:

$$\ln V_{li} = \delta_0 + \underbrace{\sum_{k=1}^{n} \frac{-\left[1-\left(1-\frac{1}{\epsilon_i}\right)\left(\sum_{k\neq l}\alpha_k\right)\right]}{\left[1-\left(1-\frac{1}{\epsilon_i}\right)\left(\sum_{k=1}^{n}\alpha_k\right)\right]}}_{\delta_k} \ln\left(\frac{w_k}{\overline{p}}\right), \tag{5}$$

with δ_0 and δ_k being functions of ϵ_i. From equation (5), the own-wage elasticity of labor demand can be easily derived:

$$\frac{\partial \ln V_{li}}{\partial \ln\left(\frac{w_l}{\overline{p}}\right)} = \delta_l = \frac{-\left[1-\left(1-\frac{1}{\epsilon_i}\right)\left(\sum_{k\neq l}\alpha_k\right)\right]}{\left[1-\left(1-\frac{1}{\epsilon_i}\right)\left(\sum_{k=1}^{n}\alpha_k\right)\right]} < 0, \tag{6}$$

with labor demand decreasing when wages increase. In line with the Hicks-Marshall law of derived demand, it can be further shown that the absolute value of the own-wage elasticity of labor demand further increases with the price elasticity of product demand:

$$\frac{\partial\left|\delta_l\right|}{\partial \epsilon_i} = \frac{\alpha_l}{\epsilon_i^2\left[1-\left(1-\frac{1}{\epsilon_i}\right)\left(\sum_{k=1}^{n}\alpha_k\right)\right]^2} > 0. \tag{7}$$

Recall that, given our assumption of non-homothetic consumer preferences across countries, the absolute value of the country-specific price elasticity increases with per-capita income (Markusen, 2013). Firms located in high-income countries such as Germany and serving its domestic market thus face a relatively lower price inelastic demand for their products, whereas firms that export some share of their output to foreign destinations, especially to low- and medium-income countries, face a more price elastic product demand, given by the weighted sales-average of the country-specific price elasticities. In accordance with equation (7), a more price elastic product demand faced by exporting rather than non-exporting firms should thus translate into a higher own-wage elasticity of labor demand.

The empirical set-up. Our empirical labor demand model is specified according to the theoretical derivation given by equation (5):

$$\ln l_{ijt} = \delta \ln w_{ijt} + \beta \ln w_{ijt} e_{it} + \lambda e_{ijt} + \boldsymbol{\gamma} \mathbf{X'}_{ijt} + \eta_i + \boldsymbol{\varphi}_{jt} + \epsilon_{ijt}. \tag{8}$$

The term $\ln l_{ijt}$ denotes the logarithm of establishment $i's$ overall employment located in industry j at time t, $\ln w_{ijt}$ the inflation-adjusted log mean wage rate and e_{ijt} the respective export variable, defined by either the export status or the export share in total sales. $\mathbf{X_{ijt}}$ is a row vector of additional covariates, including log investments of the previous year[7], the share of intermediate inputs and a dummy variable indicating whether wages are set under some form of collective bargaining agreement. We also include establishment fixed effects (η_i) as well as industry-year fixed effects, which are summarized by row vector $\boldsymbol{\varphi}_{jt}$; the error term is denoted by ε_{ijt}.

When estimating the model for N heterogeneous types of labor l^s, equation (8) is adjusted to:

$$\ln l^s_{ijt} = \sum_{k=1}^{N} (\delta_{sk} \ln w^k_{ijt}) + \beta_s \ln w^s_{ijt} e_{ijt} + \lambda_s e_{ijt} + \boldsymbol{\gamma_s} \mathbf{X'}_{ijt} + \eta_i + \boldsymbol{\varphi}_{jt} + \epsilon_{ijst} \quad \forall s. \tag{9}$$

The dependent variable becomes the log number of employees of labor type s; thus, we replace $\ln l_{ijt}$ with $\ln l^s_{ijt}$. We further control for the average wage of each skill group and interact the skill-specific wage ($\ln w^s_{ijt}$) with the export variable. The remaining variables are defined as before.

As the model is estimated in logarithms, the overall and skill-specific own-wage elasticity of labor demand are given by:

$$\left.\frac{\partial \ln l_{ijt}}{\partial \ln w_{ijt}}\right|_e = \delta + \beta e_{ijt} \quad and \quad \left.\frac{\partial \ln l^s_{ijt}}{\partial \ln w^s_{ijt}}\right|_e = \delta_{sk} + \beta_s e_{ijt}, \tag{10}$$

with βe_{ijt} and $\beta_s e_{ijt}$ representing the effect of exporting on the elasticity of labor demand, respectively. The own-wage elasticity of labor demand for firms only

[7] As we do not observe capital prices, we assume capital to be quasi-fixed and thus control for the level of capital, measured by means of log investments of the previous year.

serving their domestic market is in turn given by the single parameters δ and δ_{sk}, respectively.

Estimation and identification. We estimate overall labor demand (equation (8)) using a fixed effects instrumental variables estimator. Regarding the set of demand equations for heterogeneous types of labor (equation (9)), we use Zellner (1962)'s seemingly unrelated regression (SUR) estimation procedure – on demeaned data to capture establishment fixed effects – to explicitly account for the correlation of the error terms of each demand function within the same establishment.

By using within-establishment variation to identify the effect of exporting on labor demand, we account for time-invariant self-selection into exporting. Establishment fixed effects additionally control for unobserved time-invariant confounders such as plant location, which might affect both left- and right-hand side variables. Industry-specific shocks are captured by industry-year dummy variables.[8] In terms of the identification of the empirical model, we follow standard practice (see, for example, Hijzen and Swaim (2010) and Senses (2010)) and assume that the individual establishment faces perfectly elastic labor supply, such that wages are exogenously given for the individual plant[9] and shifts in labor supply, measured by means of changes in the wage rate, trace out the labor demand curve (Slaughter (2001)).[10]

However, the establishment's export behavior and its demand for labor depend on unobserved time-varying firm-level factors, notably productivity gains, which are not captured by using plant fixed effects. Hence, the establishment's export share in total sales (e_{ijt}), as well as the corresponding interaction term with the wage rate ($w_{ijt}e_{ijt}$), might be endogenous, which could bias our estimates.[11] Thus, we explic-

[8] We differentiate between five broad industries within the manufacturing sector: cars, steel, durables, food and non-durables.

[9] Note that the validity of our identifying assumption depends on the level of aggregation of the data used (Hamermesh, 1993). As our analysis is based on establishment-level data, simultaneity bias arising from incorrectly assuming perfectly elastic labor supply should thus be of minor concern in our analysis.

[10] To our knowledge, all existing estimates of labor demand elasticities at the plant-level rely on the assumption of exogenous wages for identification (see also Senses (2010)).

[11] Imagine unobserved gains in productivity causing a higher export share and higher level of employment. For a given wage rate, this would induce an upward bias of the interaction term between wages and the export share. Therefore, accounting for this sort of endogeneity should lead to more negative estimates of the interaction term. Consequently, our fixed effects estimates

itly account for the issue of endogeneity by applying an instrumental variables (IV) strategy. Conceptually, we follow Autor et al. (2013), who instrument U.S. imports of Chinese goods by changes in other high-income countries' imports stemming from China.[12] We adjust their approach to our research question by instrumenting the individual German establishment's export share in total sales (e_{it}) with the corresponding industry's value of US exports (in logs) destined for China. We reason for correlation between the establishment's export share and US exports to China at the corresponding industry level, given that China's demand for foreign goods should similarly affect US and German firms. However, US industry-level export volumes to China are not correlated with firm-specific productivity gains in German establishments. We derive the instrument at the two-digit industry level (22 industries within the manufacturing sector), using yearly UN Comtrade data provided by the United Nations Statistics Division (UNSD). It is important to note that we instrument both the export share as well as the interaction term of the export share and the wage rate, following the procedure suggested by Wooldridge (2010). As the instrument is derived at the 2-digit industry-level, we cluster standard errors accordingly.

4 Data

Our study is based on an administrative linked employer-employee dataset from Germany called *LIAB*, which is provided by the Institute of Employment Research (IAB).[13] As previously noted, using German data holds particular interest as its economy heavily depends on the export of its goods and services. Germany's export share of GDP (approximately 50%) is considerably higher compared to most other developed countries[14], with around two-thirds of all German exports stemming from the manufacturing sector (Mayer and Ottaviano, 2008). Moreover, Germany's strong reliance on exporting is reflected by the fact that around one-quarter of all jobs

might serve as a lower bound.

[12]Note that Dauth et al. (201x) employ an instrumental variables strategy close to Autor et al. (2013) when analyzing the effects of trade integration on local German labor markets.

[13] See Alda et al. (2005) for detailed information on this dataset.

[14] See World Trade Organization (2012) for the 2011 statistics and Figure A.1 in the Appendix.

depend either directly or indirectly on exports (Yalcin and Zacher, 2011).

Utilization of linked employer-employee data is crucial for our study, as we need to observe both individual-specific variables such as employees' occupations, qualifications and wages, as well as establishment information on output or export intensity in order to analyze the effects of exporting on the elasticities of labor demand for heterogeneous worker groups. *The employee data* is a two percent random sample of the administrative employment statistics of the German Federal Employment Agency, which covers all employees paying social security contributions (payroll taxes) or receiving unemployment benefits. Thus, the dataset does not cover self-employed or civil servants, as they are not subject to social security contributions. Among others, the dataset comprises detailed information on the individuals' qualification and occupation, their employment type (full-time, part-time or irregular employment), as well as their daily wage, right-censored at the upper earnings threshold of social security contributions. In turn, the *IAB establishment panel* is a representative, stratified, random sample of German establishments with at least one employee liable to social security. As the name indicates, the dataset focuses on the establishment rather than the aggregate, namely the firm. It has covered West and East German establishments since 1996 and contains various information on the establishments' business and employment structure, including data on investments, turnover, staff and the export share in total sales.

Following common practice, we restrict our analysis to the manufacturing sector as it accounts for the majority of Germany's total exports and displays substantial heterogeneity in terms of employment, export intensity and output.[15] Moreover, we focus on full-time employees (the vast majority in manufacturing) and restrict our analysis to establishments with at least five employees. Following Fajnzylber and Maloney (2005), we account for heterogeneous effects of trade for different groups of workers by distinguishing between blue- and white-collar labor. Relying on worker-specific occupational information, we assign each employee to one of the two occupational categories. Given that there is substantial heterogeneity among blue-collar workers, we further split this group by educational achievement. We clas-

[15] Helpman et al. (2012) reason for substantial heterogeneity in Brazilian manufacturing firms, which we also find for the German case (see Table 1).

sify employees as being high-skilled blue-collar workers in the case that they hold a tertiary college degree, received the highest German high-school diploma (Abitur) or completed vocational training. All other blue-collar workers are considered to be low-skilled. We adjust all monetary variables for inflation, notably wages and output, relying on the German consumer price index obtained from the German Federal Statistical Office. Our sample spans the period of 1996 to 2008 and ultimately comprises 5,675 establishments, which are, on average, observed 4.77 times during this period. This amounts to 27,059 establishment-year and around 7 million worker-year observations.

5 Exporting and plant characteristics

It has been well established that exporting firms differ from non-exporting firms in many aspects. In this section, we present descriptive evidence for German establishments, distinguishing between five different types of plants: (i) plants that always export; (ii) plants that never export; (iii) plants that enter the export market during the sample period; (iv) plants that stop exporting goods during the sample period; and (v) plants that change their export status more than once within our sample. Our data show that establishments' decisions to engage in exporting are long-term choices, given that 78.5% of all plants do not change the export status within our data. 12.4% of the firms change their export status once, with around 62% of these establishments entering and around 38% leaving the export market. Less than ten percent of establishments change their export status more than once.

However, variation in firms' export shares in total sales is much larger. Table 1 presents the mean export share, as well as the between- and within-plant variation in the export share for each type of plant. Overall, the mean (median) share of sales destined to foreign countries is around 33 (29)%, conditional on exporting, being higher for continuous exporters (around 38%) and lower for firms that enter the export market within the sampling period (around 20%) or change their export status more than once (around 17%).[16] The data further show that the export

[16]Note that the mean export shares given in Table 1 are independent of the actual export status in a given year. Differences in the mean export share provided in this table and presented in the

share in total sales substantially differs between firms of one type and within the establishment over time. Between-establishment variation in the export share is particularly strong for always-exporting plants, whereas within-plant variation in the export share is comparable across groups.[17]

As expected, we further find that differences in the export share are accompanied by differences in other firm characteristics. In line with the literature on exporting firms, our data shows that exporting firms are – on average – larger in terms of both output and employment, more productive[18] and pay higher wages. In

Table 1: Exporting and plant differences

Plant type	Never exporting	Always exporting	Enter exporting	Stop exporting	Var. changes of export status
Export share					
Mean value (in %)	–	38.07	12.03	9.44	8.73
Between-plants variation (std. Deviation)	–	23.90	14.59	11.10	12.34
Within-plant variation (std. Deviation)	–	8.96	13.40	11.87	10.91
Number of workers					
Mean value	43.81	454.41	159.17	196.00	173.05
Between-plants variation (std. Deviation)	149.20	1,557.08	368.35	349.91	660.25
Within-plant variation (std. Deviation)	17.49	169.85	28.18	116.57	95.86
Skill composition of workforce					
High-skilled blue-collar workers (mean)	0.64	0.55	0.61	0.60	0.61
White-collar workers (mean)	0.26	0.27	0.24	0.25	0.23
Low-skilled blue-collar workers (mean)	0.10	0.18	0.15	0.16	0.16
Average monthly wage (in logs)					
Mean value	7.58	7.94	7.75	7.76	7.75
Between-plants variation (std. deviation)	0.32	0.27	0.31	0.33	0.29
Within-plant variation (std. deviation)	0.05	0.04	0.05	0.05	0.05
Performance measures					
Output (in logs)	17.19	14.48	15.88	15.87	15.68
Value-added per worker	103,000	60,546	83,454	88,514	83,017
Investments per worker	10,030	6,739	10,031	8,679	8,176

Source: Own computations based on LIAB data. All monetary values are given in 2008 Euros.

terms of the number of workers, our data shows that always-exporting plants are considerably larger (mean: 454) than all other types of firms considered. Plants that never export are rather small, with an average number of 44 employees. Plants that

text are thus due to periods of non-exporting.

[17]Recall that identification of our labor demand model comes from within-group variation over time only.

[18] We proxy productivity by the logarithm of establishments' value-added per worker and acknowledge that this single-factor proxy might not capture their overall productivity. See Syverson (2011) for a discussion of productivity measures.

enter or leave the export market within our sample, as well as those firms switching export status more than once, are similar in terms of employment and are medium-sized, with the average number of workers ranging between 159 and 196. As for the plants' export shares, we find considerable between- and within-plant(s) variation in the number of workers employed. Despite differences in firm size, the distribution of skills is similar across plant types, with around one-quarter of the workforce being white-collar and around 60% (15%) being high-(low)-skilled blue-collar workers.[19]

Table 1 further shows that average wages are highest (lowest) in plants that always (never) export within our sample. In line with the overall pattern, average wages for the other firm types lie in-between. Between-firm variation in wages is considerable and similar across firm types. Within-plant variation in wages is smaller, yet sizeable in absolute terms. Lastly, we find that plants entering the export market within our sample have – on average – similar levels of investments per worker as always-exporting plants, but considerably higher ones compared to the remaining types of firms.

6 Empirical Results

We start by presenting our results obtained from fixed effects estimations at both the extensive (via a dummy variable) and intensive margins (by means of the establishment's export share in total sales). Recall that each specification contains industry-year fixed effects, capturing aggregate and industry-specific shocks over time, as well as establishment fixed effects. Table 2 reports the baseline results. The overall unconditional wage elasticity is -0.67 in specification (1) and thus of reasonable magnitude for a static long-run elasticity (Hamermesh, 1993). More interestingly, we find that exporting has the expected effect on the own-wage elasticity of unconditional labor demand, as indicated by the negative and significant interaction term of the log wage and export dummy: exporting increases the absolute value of the own-wage elasticity of labor demand by around 10 percent. We next turn to the intensive margin, substituting the export dummy variable with the es-

[19]This feature of our data is confirmed in the literature on exporting firms (see, for example, Bernard and Jensen (1999) or Molina and Muendler (2013)).

tablishment's export share in total sales. The results provided in column (2) of Table 2 mirror those presented in column (1), as we find that the establishment's export share has a positive and significant effect on the (absolute value of the) overall own-wage elasticity of labor demand. We find that the own-wage elasticity of labor demand for the median exporting establishment is -0.736, compared to -0.649 for a comparable non-exporting establishment.[20]

Table 2: Labor demand & exporting: fixed effects & instrumental variables results

	OLS					2SLS	
	All firms		Export=1	ΔExport=0	All firms		ΔExport=0
Dep. var: Log no. of workers	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log wage	-0.668***	-0.649***	-0.795***	-0.644***	-0.712***	-0.527***	-0.544***
	(0.089)	(0.088)	(0.155)	(0.106)	(0.101)	(0.090)	(0.135)
Log wage*export dummy	-0.071**						
	(0.031)						
Log wage*export share		-0.003***	-0.003*	-0.004**	-0.004***	-0.014***	-0.013***
		(0.001)	(0.001)	(0.002)	(0.001)	(0.004)	(0.004)
Export dummy	0.591**						
	(0.244)						
Export share		0.027***	0.021**	0.031**	0.032***	0.106***	0.101***
		(0.008)	(0.010)	(0.013)	(0.010)	(0.030)	(0.033)
Collective bargaining	0.006	0.006	0.006	0.011	0.000	0.001	0.008
	(0.010)	(0.010)	(0.015)	(0.013)	(0.010)	(0.010)	(0.012)
Log investments	0.029***	0.029***	0.031***	0.028***	0.029***	0.030***	0.029***
	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
(Share of intermediates/100)	-0.020**	-0.019*	-0.030**	-0.020*	-0.017	-0.008	-0.023***
	(0.010)	(0.010)	(0.013)	0.011)	(0.011)	(0.009)	(0.009)
Industry*Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	22,049	22,049	13,701	16,289	18,650	17,784	13,074
Overall R-Squared	0.258	0.124	0.099	0.144	0.145		
Underidentification test						11.05	11.08
Weak identification test						57.86	58.07
Endogeneity test (p-value)						0.035	0.045

Source: Own computations based on LIAB data. *Note:* All specifications include establishment and industry-year fixed effects. The constant is omitted for the ease of presentation. We provide the Kleibergen-Paap statistics for the underidentification and weak identification tests. Standard errors (in parentheses) in columns (1) to (5) are clustered at the establishment level. In columns (6) and (7), standard errors are clustered at the 2-digit industry level. Significance levels are 0.1 (*), 0.05 (**), and 0.01 (***).

Selection into exporting. In the next two specifications, we check the robustness of the baseline results with respect to firms' selection into exporting. In column (3), we restrict the sample to exporting firms only, thus focusing on the potentially selected group of exporting establishments. We find that the wage elasticity increases slightly compared to model (2), although we cannot reject that the two coefficients

[20] Note that the average export share of exporting establishments is 29%.

are identical. Moreover, the interaction term remains statistically significant, which indicates that labor demand elasticities increase with the exporting intensity, even within the group of exporters. This finding suggests that our effects are not driven by selection *into* exporting. Our model in column (4), within which we restrict the sample to establishments that do no change their export status over the observation period, corroborates this conjecture. Again, we find very similar estimates to those of specification (2).

Instrumental variables. As discussed in Section 3, our fixed effects estimates presented before are biased if both the establishment's employment decision and its export behavior are affected by unobserved time-varying factors, such as firm-specific productivity shocks. In the following, we thus present the results from our IV approach. Recall that, in the spirit of Autor et al. (2013), we instrument the establishment's export share with the corresponding US industry's export value (in logs) to China. Whereas we reason that US industry's trade volumes *are* correlated with the respective establishments' export shares, given that both are driven by China's demand for foreign goods, the instrument *is not* correlated with establishment-specific productivity shocks.

The instrument is available at the two-digit industry level, covering 1996 to 2006. To enable the comparison of point estimates, we first present baseline fixed effects on the slightly restricted sample in column (5). In line with our previous results, the export share in total sales has a positive effect on the own-wage elasticity of unconditional labor demand. Moreover, the estimates in column (5) are of similar magnitude compared to those of the baseline estimation using the full sample in column (2). We turn to our IV estimates in columns (6) and (7), first noting that our model is well identified: clustering standard errors at the level of the instrument, the Kleibergen-Paap test statistics suggest that the excluded instruments are relevant and not weak.[21] Considering the regression estimates in column (6), we find that the point estimate of the interaction term of the establishment's export share and the wage rate becomes more negative when accounting for endogeneity,

[21] The corresponding first-stage regressions are given in Table B.2 in the Appendix, where we also report the corresponding First-Stage F-test statistics, which are well above 10.

which suggests that our fixed effects estimates are biased towards zero, as argued above. In detail, the results from our instrumental variables strategy show that the own-wage elasticity for the median exporting firm is -0.931, compared to -0.527 for non-exporting firms. In column (7), we test the robustness of the IV results by restricting the sample to firms not changing the export status. Our results remain robust when restricting the sample along this dimension. We further note that the endogeneity test statistics reported at the bottom of Table 2 reject exogeneity of the potentially endogenous variables in the IV estimations. However, we cannot reject that the parameter of the interaction term in column (5), obtained from simple fixed effects estimations, is statistically different from the corresponding estimates in columns (6) and (7).

The demand for heterogeneous labor. Given that low-skilled workers in developed countries are most likely to be negatively affected by globalization, we further analyze whether exporting has differential effects on establishments' demands for heterogeneous types of labor. Recall that, following Fajnzylber and Maloney (2005), we distinguish low-skilled blue-collar from high-skilled blue-collar and white-collar workers in our analysis.

We estimate model equation (9) using fixed effects SUR to account for the fact that the error terms of the unconditional demand equations for different types of labor are likely to be correlated within the establishment.[22] Given that we do not find significant different results when applying the fixed effects instrumental variables estimator, we do not instrument exporting behavior in this specification. Table 3 shows that all estimates of own-wage labor demand elasticities are negative and statistically different from zero. Moreover, own-wage demand elasticities are lower for white-collar labor than blue-collar labor. Among the blue-collar workers, we further report higher unconditional own-wage elasticities for high-skilled than low-skilled labor.[23] More interestingly, specifications (1) to (3) of Table 3 show that exporting in itself has both a statistically and economically significant effect on the

[22] We report the corresponding estimates obtained by simple fixed effects in Table B.1 in the Appendix of this paper.

[23] However, given the share of high-skilled and low-skilled blue-collar labor in the total workforce, this result is not particularly surprising.

Table 3: Labor demand & exporting: heterogeneous labor

	Extensive margin				Intensive margin		
Dep. var.: Log number of skilled workers	high/blue	white	low/blue		high/blue	white	low/blue
Log high-skilled blue-collar wage	**-0.928*****	-0.046	-0.240***		**-.981*****	-0.037	-0.229***
	(0.038)	(0.037)	(0.053)		(0.037)	(0.037)	(0.053)
Log white-collar wage	0.050**	**-0.261*****	-0.138***		0.052**	**-0.251*****	-0.134***
	(0.024)	(0.026)	(0.035)		(0.024)	(0.026)	(0.035)
Log low-skilled blue-collar wage	0.181***	0.053***	**-0.678*****		0.181***	0.051**	**-0.671*****
	(0.021)	(0.022)	(0.035)		(0.021)	(0.022)	(0.033)
Log high-skilled blue-collar wage*export	-0.100***						
	(0.022)						
Log white-collar wage*export		-0.076***					
		(0.020)					
Log low-skilled blue-collar wage*export			-0.093***				
			(0.030)				
Log high-skilled blue-collar wage*export share					-0.003***		
					(0.001)		
Log white-collar wage*export share						-0.003***	
						(0.001)	
Log low-skilled blue-collar wage*export share							-0.003***
							(0.001)
Export dummy	0.824***	0.645***	0.748***				
	(0.173)	(0.161)	(0.228)				
Export share					0.025***	0.027***	0.026***
					(0.004)	(0.005)	(0.005)
Collective bargaining agreement	0.015*	-0.018**	0.015		0.015**	-0.017**	0.016
	(0.008)	(0.008)	(0.012)		(0.008)	(0.008)	(0.012)
Log investments	0.028***	0.022***	0.036***		0.028***	0.022***	0.036***
	(0.002)	(0.002)	(0.003)		(0.002)	(0.002)	(0.003)
(Share of intermediate inputs/100)	-0.028***	-0.039***	-0.052***		-0.027***	-0.038***	0.051***
	(0.010)	(0.010)	(0.014)		(0.010)	(0.010)	(0.014)
Industry*Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	15,714	15,714	15,714		15,714	15,714	15,714
R-Squared	0.084	0.035	0.087		0.084	0.036	0.087
Breusch-Pagan test	8,200.65	8,200.65	8,200.65		8,203.59	8,203.59	8,203.59

Source: Own computations based on LIAB data. *Note:* Columns (1), (2) and (3), as well as (4), (5) and (6), are estimated jointly using fixed effects SUREG. All specifications include establishment and industry-year fixed effects. Standard errors (in parentheses). Significance levels are 0.1 (*), 0.05 (**), and 0.01 (***). Note than "high blue", "white" and "low blue" denote the log number of high-skilled blue-collar, white-collar and low-skilled blue-collar workers, respectively. Note that the Breusch-Pagan statistics test for the independence (H0) of the residuals obtained from the three respective labor demand equations.

unconditional own-wage demand elasticity for all types of labor. Specifications (4) to (6) provide the corresponding results for the intensive margin. For each type of labor, we find the own-wage demand elasticities to significantly increase with the establishment's export share. Therefore, our results indicate that exporting at both the extensive and intensive margins renders the demand for each type of labor more elastic. Nonetheless, we do not find that low-skilled workers are particularly negatively affected by the increasing international activity of firms.

Conditional demand effects. Thus far, we have shown that exporting has a positive effect on the unconditional elasticity of labor demand. While this finding is in line with our model's prediction, we still need to rule out that differences in the conditional labor demand elasticity for exporting and non-exporting firms drive our results.

We thus depart from a static, structural model of firm behavior within which firms are assumed to minimize costs given a constant level of output. We specify costs via the flexible translog cost function (Diewert and Wales, 1987) and apply Shephard's lemma to derive the establishment's cost share equations. We estimate the cost share equations along with the cost function, allowing for non-constant returns to scale, as well as imposing linear homogeneity in input prices.[24] Conditional own-wage labor demand elasticities, $\overline{\mu}_{ii}$, are then calculated by means of:

$$\overline{\mu}_{ii} = \frac{\alpha_{ii} - \widehat{S}_i + \widehat{S}_i \widehat{S}_i}{\widehat{S}_i} \quad \forall i = 1, .., I, \tag{11}$$

with $\widehat{S}_i$ being the predicted cost share of skill group i and α_{ii} a coefficient from the regression model (see Appendix B.3).

As before, we distinguish between low-skilled blue-collar, high-skilled blue-collar and white-collar workers and estimate the model separately for exporting and non-exporting establishments, as well as for the whole sample.[25] The set of equations is estimated by SUR, demeaning the data to account for establishment fixed effects. As the parameter estimates vary depending on the cost share discarded from the system of equations, we iterate our estimations until changes in the estimated parameters become arbitrarily small (Berndt and Wood, 1975).[26]

Figure 1 reports the mean values and confidence intervals of conditional own-

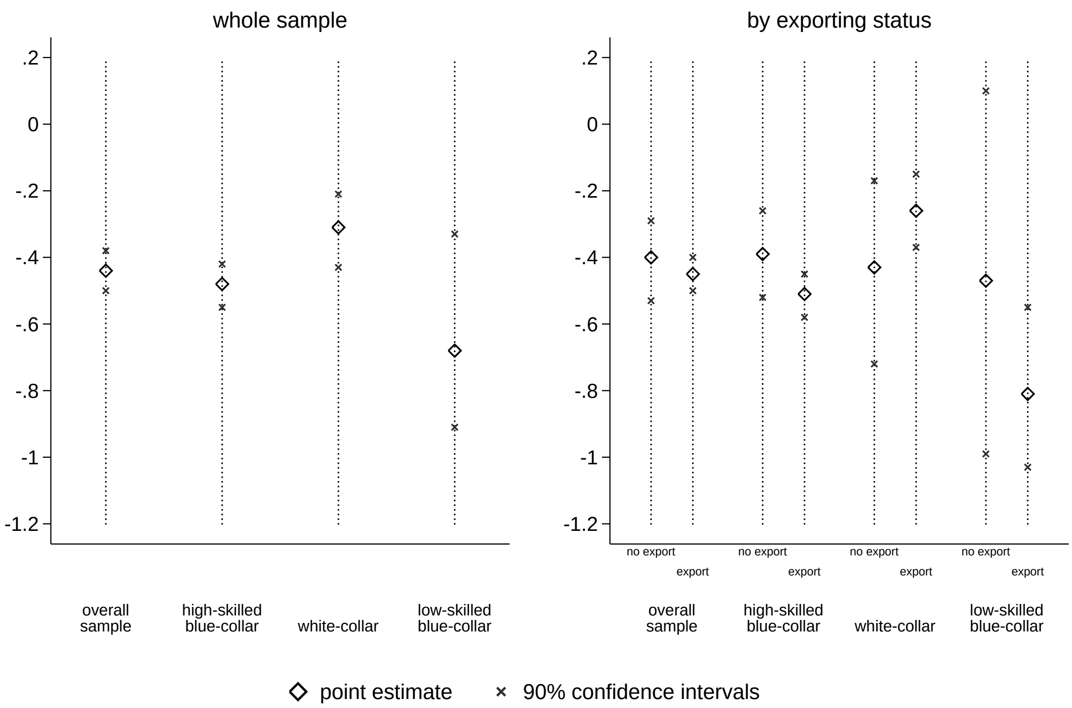
[24] The system of equations is given in Appendix B.3.

[25] Following Peichl and Siegloch (2012), we restrict the analysis of conditional labor demand to those establishments that employ at least three workers of each skill category to guarantee sufficient substitution possibilities.

[26] To ensure that our estimates are in line with the underlying theoretical assumptions, we follow Berndt (1991) and test whether the cost functions are monotonically increasing in input prices, the estimated cost shares are non-negative for each observation and the cost function is quasi-concave in input prices. Regression results and test statistics for the respective equations are provided in Tables B.4, B.5 and B.6 in the Appendix.

wage labor demand elasticities for high-skilled blue-collar, white-collar, low-skilled blue-collar and overall labor.[27] The left panel displays the overall conditional own-wage elasticities. We note that all elasticities are significantly different from zero and negative, as postulated by theory. The overall constant-output wage elasticity of labor demand is -0.44. Moreover, we find the expected pattern of wage elasticities in terms of skills, with the estimated own-wage elasticities for white-collar workers being lowest in absolute terms, which is not surprising given that the majority of white-collar workers in manufacturing are high-skilled. In line with the empirical literature, the mean own-wage elasticity for low-skilled blue-collar labor is higher compared to the corresponding elasticities for high-skilled blue-collar and white-collar labor, in absolute terms.[28]

Figure 1: Conditional own-wage elasticities for different types of labor



In the right panel of Figure 1, conditional own-wage labor demand elastici-

[27] Standard errors are obtained by bootstrapping the set of equations using 400 replications. All mean elasticities and the corresponding standard errors are provided in Table B.3 in the Appendix. The own-wage elasticities for overall employment are calculated as the establishment's average of the three estimated elasticities weighted by the respective cost share.

[28]As the confidence interval for the low-skilled, blue-collar workers is particularly large, the differences in the wage elasticities by skill are not statistically significant.

ties are provided separately for exporting and non-exporting establishments. When comparing the overall conditional elasticity, we find very similar values for exporting (-0.41) and non-exporting establishments (-0.45). The same picture emerges when considering the demand elasticities for different skill groups: we do not find statistically different conditional own-wage labor demand elasticities between exporting and non-exporting establishments for any of the three skill groups.[29]

Thus, we find no evidence that differences in unconditional labor demand elasticities for exporting and non-exporting firms are driven by different conditional elasticities. By the Hicks-Marshall law of derived demand, this finding implies that the higher unconditional labor demand elasticities of exporting firms are due to higher product demand elasticities, as predicted by our theoretical model.

Interestingly, while conditional elasticities tend to be slightly higher for both types of blue-collar workers in exporting plants, the opposite seems to be true for white-collar labor, at least when comparing point estimates. This could be cautiously interpreted in favor of Matsuyama (2007), who suggests that exporting firms face more skill-intensive tasks (e.g. by requiring workers with foreign language skills or experience in international business) than non-exporting firms, which should translate into higher demand for skilled labor, conditional on output.

7 Conclusions

In this paper, we show that globalization increases worker vulnerability by demonstrating that firms' exporting activity has a positive and significant effect on the absolute value of the own-wage elasticity of labor demand. As it has been shown that firms are faced with destination-specific price elasticities of product demand that are decreasing in per-capita income of the destination country, exporting firms located in high-income countries are exposed to an overall more price elastic product demand than a comparable firm serving its domestic market only. Building on the theoretical model of Krishna et al. (2001) and assuming non-homothetic consumer preferences across countries, we show that (i) in line with the Hicks-Marshall law of

[29] In line with Koebel et al. (2003), we report higher standard errors and confidence intervals for the estimated own-wage elasticities of those inputs with a low cost share.

derived demand, the own-wage elasticity of labor demand increases with the price elasticity of product demand in a model within which firms have some price-setting power; and (ii) more elastic product demand for exporting rather than non-exporting firms transmits to higher own-wage elasticities for firms engaged in exporting.

In our empirical analysis, we verify the theoretical predictions by showing that both exporting per se as well as the export share in total sales have a positive and significant effect on the unconditional own-wage elasticity of labor demand. Our fixed effects-instrumental variable estimator yields an own-wage elasticity for the median exporting plant of -0.93, compared to -0.53 for non-exporting plants. We show that our results are not driven by selection into exporting, given that restricting the sample to the potentially selected subset of exporting plants or those not changing the export status does not change the results. We further find that our results are not due to differences in the conditional elasticity of labor demand, taking these results as suggestive evidence in favor of our proposed mechanism.

Our findings have important policy implications. At present, the newly elected German government is debating the introduction of a general minimum wage. As it has been shown that the optimal minimum wage policy depends on the wage elasticity of labor demand (Lee and Saez, 2012), the optimal policy would be different in trade-exposed and trade-sheltered sectors. Moreover, the same is true for other policies increasing wage costs for employers. In terms of future research, it would be interesting to revisit our results using comparable datasets, yet with more information on the country-specific export pattern of each firm, as well as for a developing country with strong trade ties to high-income countries, where our mechanism suggests reverse effects on the elasticity of labor demand.

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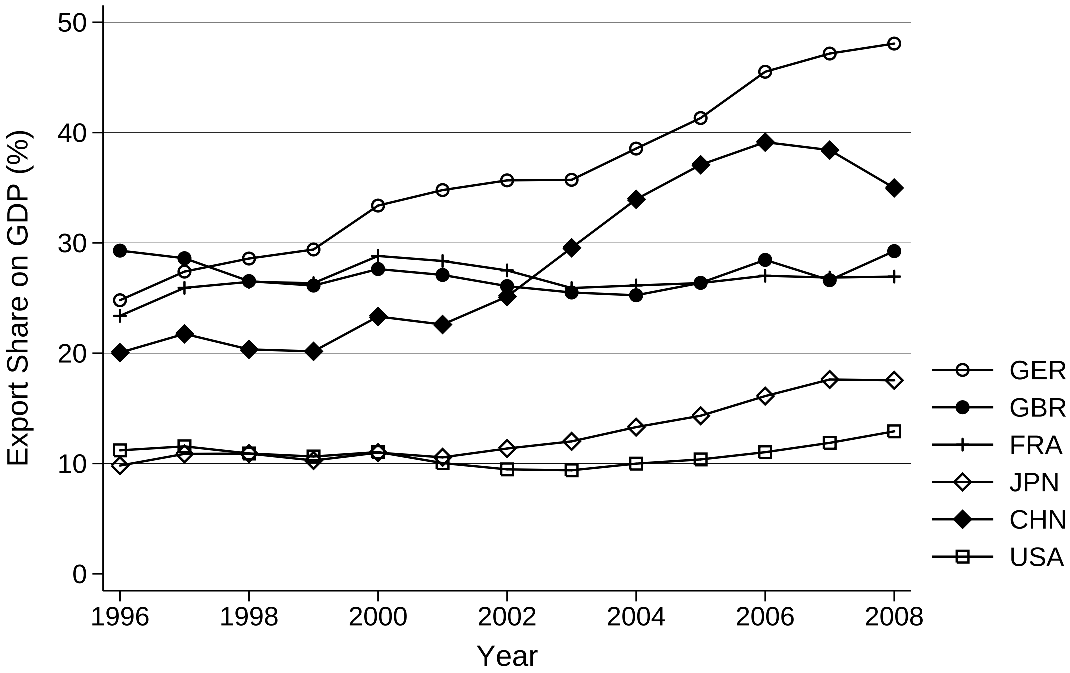
A Appendix: Descriptive Statistics

Figure A.1: Export share on national GDP



Source: http://data.worldbank.org/indicator/NE.EXP.GNFS.ZS

B Appendix: Additional Regression Results

B.1 Heterogeneous Labor Demand

Table B.1: Fixed effects estimates

	Extensive margin			Intensive margin		
Dep. var.: log number of skilled workers	high/blue	white	low/blue	high/blue	white	low/blue
Log high-skilled blue-collar wage	**-0.982*****	-0.059	-0.209	**-0.978*****	-0.048	-0.206
	(0.128)	(0.091)	(0.152)	(0.126)	(0.092)	(0.152)
Log white-collar wage	0.062	**-0.262*****	-0.048	0.065	**-0.238*****	-0.046
	(0.061)	(0.079)	(0.074)	(0.061)	(0.077)	(0.074)
Log low-skilled blue-collar wage	0.186***	0.051	**-0.630*****	0.186***	0.049	**-0.631*****
	(0.044)	(0.038)	(0.072)	(0.045)	(0.039)	(0.071)
Log high-skilled blue-collar wage*export	-0.109**					
	(0.053)					
Log white-collar wage*export		-0.065				
		(0.041)				
Log low-skilled blue-collar wage*export			-0.047			
			(0.053)			
Log high-skilled blue-collar wage*export share				-0.003***		
				(0.001)		
Log white-collar wage*export share					-0.004***	
					(0.001)	
Log low-skilled blue-collar wage*export share						-0.002
						(0.001)
Export dummy	0.894**	0.558*	0.399			
	(0.414)	(0.331)	(0.406)			
Export share				0.028***	0.033***	0.013
				(0.010)	(0.011)	(0.010)
Collective bargaining agreement	0.012	-0.019	-0.007	0.012	-0.018	-0.006
	(0.016)	(0.014)	(0.024)	(0.016)	(0.014)	(0.024)
Log investments	0.027***	0.022***	0.031***	0.027***	0.022***	0.031***
	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.004)
(Share of intermediate inputs/100)	-0.022*	-0.037***	-0.007	-0.022*	-0.036***	-0.007
	(0.013)	(0.014)	(0.018)	(0.013)	(0.014)	(0.019)
No. of observations	15,714	15,714	15,714	15,714	15,714	15,714
Overall R-Squared	0.033	0.028	0.0910	0.024	0.030	0.090

Source: Own computations based on LIAB data. *Note:* All specifications include year and year*branch fixed effects. The constant is omitted for the ease of presentation. Standard errors (in parentheses) are clustered at the establishment level. Significance levels are 0.1 (*), 0.05 (**), and 0.01 (***). Note than "high blue", "white" and "low blue" denote the log number of high-skilled blue-collar, white-collar and low-skilled blue-collar workers, respectively.

B.2 Instrumental Variables Estimation

Table B.2: Additional Results

(A) Initial regression of the export share on the instrument

Export share	Whole sample
Log US industry exports	0.841*
	(0.484)
Log wage	1.727
	(2.077)
Log investments	0.223**
	(0.094)
Collective bargaining agreement	0.372
	(0.373)
Share of intermediate inputs	1.655***
	(0.580)
No. of observations	18,650
No. groups	5,002

(B) First-stage estimation results from 2SLS

(1) Export share	Whole sample	No change in export status
Log wage	-5.007***	-5.520**
	(1.527)	(2.079)
Log investments	-0.169*	-0.087
	(0.096)	(0.108)
Collective bargaining agreement	-0.298	-0.311
	(0.309)	(0.398)
Share of intermediate inputs	-1.116***	-2.193***
	(0.461)	(0.590)
Predicted log US exports to China	1.476*	0.145
	(0.791)	(0.538)
Predicted log US exports to China*log wage	0.069	0.191***
	(0.058)	(0.091)
No. of observations	17,784	10,670
F-Test of excluded instruments	61.54	86.59

(2) Interaction of wage and export share	Whole sample	No change in export status
Log wage	-40.922***	-44.805***
	(12.210)	(16.746)
Log investments	-1.276	-0.618
	(0.752)	(0.853)
Collective bargaining agreement	-2.370	-2.475
	(2.392)	(3.181)
Share of intermediate inputs	-8.399**	-17.162***
	(3.752)	(4.765)
Predicted log US exports to China	3.257	-7.184
	(3.694)	(4.224)
Predicted log US exports to China*log wage	1.589***	2.552***
	(0.479)	(0.456)
No. of observations	17,784	13,074
F-Test of excluded instruments	62.02	104.82

Source: Own computations based on LIAB data. *Note:* All specifications include establishment and industry-year fixed effects. Standard errors (in parentheses) in column (1) are clustered at the establishment level. Significance levels are 0.1 (*), 0.05 (**), and 0.01 (***).

B.3 Conditional Labor Demand

As given by Diewert and Wales (1987), we define costs C according to:

$$\begin{aligned}\ln C(w_i, Y) =& \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln w_i + 0.5 \sum_{i=1}^{n}\sum_{j=1}^{n} \alpha_{ij} \ln w_i \ln w_j + \beta_Y \ln Y \\ &+ \sum_{i=1}^{n} \beta_{iY} \ln w_i \ln Y + 0.5 \beta_{YY} (lnY)^2 + \eta_t t\end{aligned}$$

In order to ensure linear homogeneity in factor prices as well as to allow for non-constant returns to scale, several restrictions on the parameters are imposed:

$$\alpha_{ij} = \alpha_{ji} \qquad \sum_{i=1}^{n} \alpha_i = 1 \qquad \sum_{i=1}^{n} \alpha_{ij} = 0 \qquad \sum_{i=1}^{n} \beta_{iY} = 0.$$

Applying Shephard's lemma (Shephard, 1970) and exploiting the fact that the cost function is logarithmized, the cost shares may be denoted as:

$$S_i = \frac{w_i X_i}{C} = \frac{\partial \ln C(w_i, Y)}{\partial \ln w_i} = \alpha_i + \sum_{j=1}^{n} \alpha_{ij} \ln w_j + \beta_{iY} \ln y + \eta_t t + \varepsilon_{it} \quad \forall i.$$

We estimate the cost function jointly with N-1 share equations by SUR, accounting for establishment fixed effects by demeaning the data.

Table B.3: Conditional labor demand elasticities and corresponding standard errors

Own-Wage Elasticity	Non-exporting plants only	Exporting plants only	Whole sample
High-skilled blue-collar	-0.39	-0.51	-0.48
	(0.08)	(0.04)	(0.04)
White-collar	-0.43	-0.26	-0.31
	(0.17)	(0.07)	(0.07)
Low-skilled blue-collar	-0.47	-0.81	-0.68
	(0.39)	(0.30)	(0.22)
Overall	-0.40	-0.45	-0.44
	(0.06)	(0.03)	(0.03)

Source: Own computations based on LIAB data. *Note:* Mean own-wage elasticities of heterogeneous labor demand. Standard errors (in parentheses) obtained from bootstrapping using 400 replications.

Table B.4: Conditional labor demand estimates for non-exporting establishments

Theoretical Fit:
Share of predicted cost shares < 0 : 0.1
Share of strict quasi-concave cost functions: 87.27%
Share of violated adding-up conditions: 0

Dependent Variable:	Cost share ($\ln l^w$)	Cost share ($\ln l^{lb}$)	Cost function (C)
Ln(w^w)/Ln(w^{hb})	0.055***	-0.025***	
	(0.010)	(0.007)	
Ln(w^{lb})/Ln(w^{hb})	-0.025***	0.027***	
	(0.007)	(0.010)	
Ln(value-added)	0.001	0.003**	-0.057
	(0.001)	(0.001)	(0.049)
Ln(w^{hb})			1.000***
			(0.001)
Ln(w^w)			-0.000
			(0.001)
Ln(w^{lb})			-0.000
			(0.001)
Ln(w^w)*ln(w^{lb})			-0.025***
			(0.007)
Ln(w^w)*ln(w^{hb})			-0.030***
			(0.010)
Ln(w^{lb})*ln(w^{hb})			0.002
			(0.010)
Ln(w^{hb})*ln(value-added)			-0.004**
			(0.001)
Ln(w^w)*ln(value-added)			0.001
			(0.001)
Ln(w^{lb})*ln(value-added)			0.003***
			(0.001)
Ln(w^{hb})^2			0.31**
			(0.015)
Ln(w^w)^2			0.055***
			(0.010)
Ln(w^{lb})^2			0.027***
			(0.010)
Ln(value-added)^2			0.009***
			(0.003)
Number of observations	2,663	2,633	2,663
Parameters	15	15	21

Source: Own computations based on LIAB data. *Note:* All equations include year-fixed effects and a constant term. Standard errors (in parentheses). Significance levels are 0.1 (*), 0.05 (**), and 0.01 (***).

Table B.5: Conditional labor demand estimates for exporting establishments

Theoretical Fit:
Share of predicted cost shares $< 0 : 0.001$
Share of strict quasi-concave cost functions: 85.46%
Share of violated adding-up conditions: 0

Dependent Variable:	Cost share ($\ln l^w$)	Cost share ($\ln l^{lb}$)	Cost function (C)
Ln(w^w)/Ln(w^{hb})	0.096***	-0.054***	
	(0.006)	(0.004)	
Ln(w^{lb})/Ln(w^{hb})	-0.054***	0.000	
	(0.004)	(0.005)	
Ln(value-added)	0.001*	0.003***	-0.014
	(0.001)	(0.001)	(0.029)
Ln(w^{hb})			1.000***
			(0.000)
Ln(w^w)			0.000
			(0.000)
Ln(w^{lb})			-0.000
			(0.000)
Ln(w^w)*ln(w^{lb})			-0.054***
			(0.004)
Ln(w^w)*ln(w^{hb})			-0.042***
			(0.005)
Ln(w^{lb})*ln(w^{hb})			0.054***
			(0.005)
Ln(w^{hb})*ln(value-added)			-0.004***
			(0.001)
Ln(w^w)*ln(value-added)			0.001*
			(0.000)
Ln(w^{lb})*ln(value-added)			0.003***
			(0.000)
Ln(w^{hb})^2			-0.011
			(0.007)
Ln(w^w)^2			0.096***
			(0.006)
Ln(w^{lb})^2			0.000
			(0.005)
Ln(value-added)^2			0.005***
			(0.002)
Number of observations	10,781	10,781	10,781
Parameters	15	15	21

Source: Own computations based on LIAB data. *Note:* All equations include year-fixed effects and a constant term. Standard errors (in parentheses). Significance levels are 0.1 (*), 0.05 (**), and 0.01 (***).

Table B.6: Conditional labor demand estimates for the whole sample

Theoretical Fit:
Share of predicted cost shares < 0 : 0.001
Share of strict quasi-concave cost functions: 86.48%
Share of violated adding-up conditions: 0

Dependent Variable:	Cost share ($\ln l^w$)	Cost share ($\ln l^{lb}$)	Cost function (C)
Ln(w^w)/Ln(w^{hb})	0.083***	-0.047***	
	(0.005)	(0.003)	
Ln(w^{lb})/Ln(w^{hb})	-0.047***	0.010**	
	(0.003)	(0.004)	
Ln(value-added)	0.001*	0.003***	-0.042*
	(0.001)	(0.000)	(0.025)
Ln(w^{hb})			1.000***
			(0.000)
Ln(w^w)			0.000
			(0.000)
Ln(w^{lb})			0.000
			(0.000)
Ln(w^w)*ln(w^{lb})			-0.047***
			(0.003)
Ln(w^w)*ln(w^{hb})			-0.037***
			(0.005)
Ln(w^{lb})*ln(w^{hb})			0.037***
			(0.004)
Ln(w^{hb})*ln(value-added)			-0.004***
			(0.001)
Ln(w^w)*ln(value-added)			0.001**
			(0.001)
Ln(w^{lb})*ln(value-added)			0.003***
			(0.000)
Ln(w^{hb})^2			-0.000
			(0.006)
Ln(w^w)^2			0.083***
			(0.005)
Ln(w^{lb})^2			0.010**
			(0.004)
Ln(value-added)^2			0.007***
			(0.002)
Number of observations	13,444	13,444	13,444
Parameters	15	15	21

Source: Own computations based on LIAB data. *Note:* All equations include year-fixed effects and a constant term. Standard errors (in parentheses). Significance levels are 0.1 (*), 0.05 (**), and 0.01 (***).