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ABSTRACT

HOW FOREIGN-BORN WORKERS FOSTER EXPORTS

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We investigate the export-enhancing effect of foreign workers at the firm level. We first develop a theoretical framework of heterogeneous firms, assuming that foreign workers allow for productivity gains and convey valuable information on foreign markets. We illustrate that foreign workers foster exports at the extensive and the intensive margins. This effect can be decomposed in a general effect – to which any foreign worker contributes – and a destination-specific effect – to which only foreign workers who were born in the export destination contribute. We test these theoretical predictions using French firm-level data over the 1997-2008 period and a propensity score matching method to address endogeneity concerns. We find that foreign-born workers, and especially skilled individuals, foster exports at both margins. On average, a firm employing foreign-born workers exports 30% more in value than a control firm. We find evidence that this increase is spread over all destinations, suggesting that the effect of foreign-born workers goes beyond a destination-specific informational channel.

Keywords: Foreign-born workers, Exports, Firms, Heterogeneity, Productivity
JEL classification: F14, F22, F16

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1 Introduction

An extensive literature investigates the firm-level determinants of trade performance on foreign markets. Empirical regularities suggest that trade outcomes are mainly determined by (i) the idiosyncratic firm characteristics and (ii) the capacity of the firm to overcome large country-specific trade costs. Successful exporters are more productive and larger in terms of employment, capital-intensity and financial capabilities as compared to non-successful exporters and non-exporting firms (Bernard et al., 2012). This within-industry selection of exporting firms through productivity has been rationalized by the seminal model of Melitz (2003). On the other hand, informational barriers which are usually approximated by the geographic and cultural distance between countries, are known to deter export outcomes (Disdier and Head, 2008).

Foreign workers impact both aforementioned trade determinants. First, some papers show that employing foreign workers generates a productivity-enhancing task specialization within the firm (Peri and Sparber, 2009). This literature echoes another strand of results supporting the productivity-enhancing effect of cultural and ethnic diversity among skilled workers (Goldin et al., 2011; Trax et al., 2015). So far, only a limited attempt has been done to bridge this literature investigating the productivity effect of immigrants, and the trade-migration literature. To the best of our knowledge, Mitaritonna et al. (2016) are the first to explicit the link between foreign workers, productivity and exports.

Second, a number of studies provide evidence that immigrants convey valuable information on their origin countries which decreases *ad valorem* and fixed costs faced by exporters. Thus, they foster trade between their origin and host countries at the extensive and the intensive margins. These results have mainly been supported by macro-level studies (Gould, 1994; Rauch, 2001; Parsons and Winters, 2014). At the firm level, the impact of the firm's workforce on its export outcomes has attracted little attention. Hiller (2013) shows that firms should employ foreign workers in order to access the knowledge embedded in the foreign population. Both Hiller (2013) and Hatzigeorgiou and Lodefalk (2016) find that an increase in foreign employment at the firm level is associated with an increase in exports to the immigrant origin country.

In the present paper, we investigate the different channels through which foreign workers impact firm-level exports at both margins. To this end, we develop a theoretical framework with heterogeneous firms in monopolistic competition resting upon the model of Melitz (2003). We assume that foreign workers allow their firm to be more productive, and convey valuable information to their employer on foreign markets, particularly on their origin country. Our model predicts that foreign workers foster exports at both margins toward any destination country. This effect can be decomposed in a general effect – to which any foreign worker contributes – and a destination-specific effect – to which only foreign workers who were born in the export destination contribute. Doing so, we show that export cutoffs are destination- and firm-specific and depend on the firm's exogenous productivity and its employment of foreign workers.

We test these predictions using a dataset on French manufacturing firms over the 1997-2008 period. We identify foreign-born workers in a comprehensive matched employer-employee dataset (from firms' annual employee declarations) that we combine with trade data at the

firm-destination level (from the French customs) and balance sheet data (from the French tax authority). Aware of the reverse causality bias – foreign employment is potentially driven by firm-level export performance – we take full advantage of the firm-level data by estimating the trade-induced effect of foreign-born workers using a propensity score matching (PSM) approach. We estimate the effect of multiple treatments – all related to foreign employment – on export outcomes. In other words, we estimate the difference in export outcomes coming from differences in foreign employment. We find that both margins positively react to the employment of foreign-born workers. On average, a firm employing foreign-born workers exports 30% more in value than a control firm. This pro-trade effect is not restricted to skilled workers: unskilled foreign employment is also associated to a pro-trade effect, in particular for the intensive margin. Then, our results show that foreign employment matters not only for exports toward immigrants' origin countries but toward any export destination, which directly relates to a pro-trade effect of foreign workers at the intensive margin. This result can be attributed to a productivity-enhancing effect and/or an informational effect of foreign workers, as support by theory. Our results are robust to alternative matching procedures, alternative sub-samples and alternative treatments that all inform us about how foreign workers favor exports.

The contributions of the paper are the following. First, we propose a theoretical model of heterogeneous firms rationalizing the export-enhancing effect of foreign workers. To the best of our knowledge, the only attempt to provide a theoretical framework to show how migrants foster trade has been made by Felbermayr and Toubal (2012). We depart from this article by providing a heterogeneous-firm approach to this research question and by focusing on the export side. Moreover, we rationalize the effect of foreign employment on the intensive margin of trade, while most papers focus on the extensive margin.

Second, we depart from existing empirical studies on the trade-migration nexus by proposing a firm-level analysis and an alternative estimation strategy to insulate our results from reverse causality. While most papers tend to overcome endogeneity issues using regional-level variables to instrument the firm's foreign employment, we estimate the trade-induced effect of employing foreign workers thanks to a PSM approach. This method allows us to rely on firm-level information, instead of aggregate migration data. On top of that, our strategy allows us to show that, within local labor markets, foreign employment favors exports. Our results thus complement existing studies investigating the trade-migration nexus at the local level.

Finally, we provide additional insights to the black-box of export success and failure. Despite recent contributions, what makes an exporter successful is still not fully rationalized. Our analysis provides evidence of an additional determinant of firms' export success.

The rest of the paper is organized as follows. In the next section, we present the related literature. In Section 3, we present the French firm-level data and a set of stylized facts. In Section 4, we develop a theoretical framework rationalizing the effect of foreign workers on exports, that we estimate in Section 5. The latter section displays a first set of results supporting the pro-trade effect of foreign-born workers derived from a PSM approach. We pursue our

analysis in Section 6 by providing further evidence that foreign workers favor exports to any destination, and not only to their origin country. Section 7 concludes.

2 Exports and immigration

The preference and informational channels

A large set of papers provide aggregate evidence on the pro-trade effect of immigrants. The seminal papers of Gould (1994) and subsequent work surveyed by Rauch (2001) and Parsons and Winters (2014) highlight two channels. First, immigrants convey information and promote trust between their home and host countries. Their social capital reduces transaction costs, which fosters bilateral trade (both exports and imports). Second, immigrants expand bilateral imports due to their preferences for the goods produced in their home country.

Felbermayr and Toubal (2012) attempt to quantify the two aforementioned channels. Using stocks of foreign individuals in OECD countries in 2000, they find that the pro-trade effect of immigrants on bilateral trade accounts for 37% of the total effect, the remaining 63% being attributed to the preference channel.

Most studies suggest that immigrants exert a greatest pro-trade effect on differentiated goods for which the price fails to transmit relevant information. The literature also suggests a larger pro-trade effect of skilled and voluntary migrants, with respect to low educated and forced migrants. Finally, as documented by Hatzigeorgiou and Lodefalk (2014), existing studies adopting instrumental variable techniques show that the causal relation runs from immigration to trade.

A limited number of studies use firm-level data to analyze how immigrants impact exports. Hiller (2013) shows that immigrants may reduce both *ad valorem* and fixed export costs by relaxing informational barriers thanks to their superior knowledge of foreign-markets. Nonetheless, in order to access the knowledge embedded in the foreign population of their country, firms should indeed employ foreign workers. Using employer-employee data on Danish manufacturing firms over 1995-2005, she finds that foreign employment increases the exported quantities and impacts the composition of exports, while the local presence of foreigners has a limited impact on exports. To highlight causality, she instruments foreign employment by the average number of immigrants from a given origin employed in other firms in the same industry, or in the same region of the firm. Yet, as pointed out by Parsons and Winters (2014), she assumes that regional immigrant stocks are exogenous to the firm, while arguing that foreign employment is correlated with the local presence of foreigners, which slightly weakens her argument.

Similarly, Parrotta et al. (2016) use Danish employer-employee data over the 1995-2007 period, to investigate the causal effect of an increase in labor force ethnic diversity on export outcomes at both margins. They measure diversity using differences in spoken languages across workers. They find that more diverse firms perform better on foreign markets along all extensive margin measures. These firms have a higher "relational capital" which translate into an increased ability to initiate, manage, and expand international business. To control for endogeneity, they use a shift-share instrument *à la* Card (2001) to identify supply-driven diversity from exogenous

changes in the local labor supply in the 1990's. Doing so, they assume a correlation between past and contemporaneous immigration, and that individual firms do not impact local economic outcomes. Yet, the latter argument can be challenged in case of large firms and small sectors in the Danish economy.

Then, Hatzigeorgiou and Lodefalk (2016) use Swedish employer-employee data over 1998-2007 and find that foreign-born workers (in particular skilled and recently arrived) increase exports at both trade margins, all the more for small firms. To overcome endogeneity bias, they use a GMM estimator and instrument the firm-level employment of foreign-born workers with the average foreign employment in other Swedish firms and the average foreign employment in the firm's industry. Their instrument is valid under the assumption that firm employment strategies are exogenous to prior trade relationships. To convince the reader, they present a Swedish business survey which indicates that hiring of foreign workers may not necessarily be endogenous to trade.

Theoretically, the effect of immigration on exports has been rationalized by Peri and Requena-Silvente (2010) using the model of Chaney (2008). The assume that immigrants lower fixed export costs. Thus, less productive firms that were below the productivity threshold to export, become able to enter the export market when employing immigrants. They conclude that the trade-enhancing effect of immigrants should take place at the extensive margin, and corroborate this prediction using data on Spanish provinces over the 1995-2008 period. However, their theoretical model is not fully in line with empirical evidence, as some studies also find an effect on the intensive margin, supporting the idea that immigrants do not only reduce fixed export costs. To fully rationalize the export-enhancing effect of immigrants, on both trade margins, one also needs to assume that immigrants either lower *ad valorem* export costs (through the informational channel) or increase firm productivity.

The productivity channel

The indirect impact of foreign employment on firm productivity has been put forward by Peri and Sparber (2009). In their seminal paper, they show that natives and immigrants are imperfect substitutes. The employment of immigrants thus generates a task specialization within firms, and generated gains prevent natives' wages to decrease due to immigration.

Recently, Mitaritonna et al. (2016) explicitly analyze the link between immigration and productivity gains. Using French firm-level data over the 1995-2005 period, they find that an increase in the local supply of immigrants increases total factor productivity of firms located in that area. This effect is found to be stronger for firms with initially low productivity and small size. In addition, the authors find that this positive productivity effect was associated with larger exports. To address potential endogeneity, they instrument the local supply of immigrants by a shift-share instrument based on the spatial distribution of immigrants in 1990. This method rest upon the idea that past and contemporaneous immigration shares are highly correlated due to network effects. The authors exclude the possibility that the spatial distribution of immigrants

in 1990 could be correlated with changes in labor demand due to firms' productivity shocks, arguing that local economic outcomes are not impacted by individual firms.

A emerging strand of the literature shows that cultural diversity eventually increases firm productivity, for instance, by enhancing innovation and problem solving (Goldin et al., 2011). Trax et al. (2015) use data on a sample of German firms over 1999-2008 to analyze the link between cultural diversity and firm productivity. They find that the share of foreign employment has no impact on productivity, while the diversification of the workforce with respect to nationalities increases total factor productivity. In addition, regional diversification significantly impacts firm productivity. To insulate their results from reverse causality, the authors use a GMM approach and construct a shift-share instrument using regional employment shares by nationalities in 1987 and nationwide employment growth rates for each nationality. Then, this instrument is interacted with the firm's share of foreign employment with respect to the regional foreign employment.

Nonetheless, some papers show that ethnic diversity can create linguistic and cultural frictions, which can create communication problems and weaken social ties between workers. Using Danish employer-employee data over 1995-2005, Parrotta et al. (2014) find evidence that a firm's workforce diversity in ethnicity negatively impacts its total factor productivity. They tackle reverse causality by constructing a shift-share instrument where the firm's diversity is instrumented using the local diversity of the labor supply. The latter is constructed using the 1990's composition and contemporaneous population stocks. A number of papers in management sciences also present mixed evidence regarding the advantages of multiculturalism at the firm level (Loth, 2009; Goodall and Roberts, 2003).

3 Data and stylized facts

3.1 Data

We merge three datasets providing us information on French firms over the 1997-2008 period, using a unique administrative French firm identifier (the SIREN number).

Administrative employer-employee data

First, we use the firms' annual employee declarations (Déclarations Annuelles des Données Sociales, DADS) containing exhaustive information on the employment of firms settled on the French metropolitan territory from 1997 to 2008. This administrative database is made of compulsory reports provided by each employer on the gross earning of his employees. All wage-paying individuals and legal entities established in France are required to file payroll declarations; only individuals employing civil servants are excluded from filing such declarations. The dataset is thus made of information at the firm-employee-year level.

More especially, we have information about the geographical zone of birth of each worker. The *etrang* variable allows us to know whether an employee was born in France or in a foreign

country.[1] We assume that when the *etrang* variable is left empty, the worker was born in France. The dataset however does not contain information about the exact country of birth of foreign workers. In the rest of the paper, we consider foreign workers as foreign-born workers. Note that we cannot identify naturalized individuals who thus are considered as foreigners. We also have information on the socio-professional category of each worker. We combine this information with a classification of categories into white- and blue-collar occupations to identify skilled and unskilled workers (Bombardini et al., 2015).

We aggregate this dataset at the firm-level and count, for each firm, the number of native and foreign workers for each skill category. After removing obvious outliers and extreme values, DADS data are in line with macro-level evidence. For instance, in 2006 in the *Ile-de-France* region, 13.6% of workers are foreign-born, while the partial 2006 census estimates that immigrants represent 12.9% of the working-age population. The final sample is made of 21,157,647 observations at the firm-year level, that corresponds to an average of 2,000,000 firms per year. In this sample, foreign-born workers represent 7.49% of all workers, which is close to the estimates proposed by Brücker et al. (2013).

The advantage of using firm-level data in our case is twofold. First, we rely on firm-level data to solely focus on the immigrant working population. Conversely to census data, our dataset exhaustively covers the employment of foreigners in France. This dataset is thus particularly appropriate for a consistent identification of the pro-trade effect of foreign workers on exports, within the firm boundaries. Additionally, it allows us to identify firm-level mechanisms that cannot be captured using aggregate data, in which the causal direction may be flawed. Second, our dataset allows us to estimate the proper trade effect of the employed foreigners by the firm, while existing study using regional immigration data tend to estimate the effect of immigration on the average local firm performance, also accounting for externalities arising from the proximity of immigrants.

Customs trade data

We then use firm-level trade data from the French customs over the 1997-2008 period. This database reports the volume (in tons) and the value (in Euros) of exports for each CN8 product (European Union Combined Nomenclature at 8 digits) and destination, for each firm located on the French metropolitan territory. Some shipments are excluded from this data collection. Inside the EU, firms are required to report their shipments by product and destination country only if their annual export value exceeds the threshold of 150,000 Euros. For exports outside the EU, all flows are recorded unless their value is smaller than 1,000 Euros or one ton. Yet, these thresholds eliminate a very small share of the total exports. From this dataset, we only keep merchandise shipments, excluding agricultural and services exports.

[1] The DADS data allow us to distinguish two categories of foreign workers: those born inside the European Union, and others. In the remaining of the paper, we do not exploit that information because the group of foreign workers born outside the EU is to broad. To use this group, one would need to assume that a workers born in Switzerland eventually has the same pro-trade impact than a worker born on another continent.

The dataset consists of 26,186,006 observations at the firm-year-destination-product level, that we aggregate into 7,110,894 observations at the firm-year-destination level and into 1,381,500 observations at the firm-year level. Once combined with the DADS data, we obtain a dataset of 21,157,647 firm-year observations over the 1997-2008 period, in which 1,043,790 are exporters (representing 98% of total French exports) and 20,113,857 are non-exporting firms.

Balance-sheet data

We complete the picture using a balance-sheet dataset constructed from reports of French firms to the tax administration over the 1997-2008 period (Bénéfices Réels Normaux, BRN). This dataset contains information on the value added, total sales, capital stock, debt structure and other variables at the firm level. Importantly, this dataset is composed of both small and large firms, since no threshold applies on the number of employees for reporting to the tax administration.

The dataset contains between 550,000 and 650,000 firms per year (around 50% of the total number of French firms). In total, the dataset is made of 5,850,838 firm-year observations of which 5,425,621 can be merged into the sample of 21,157,647 firm-year observations. Depending on the year, these firms represent between 90% and 95% of French exports contained in the customs data.

3.2 Stylized facts

Descriptive statistics are reported in Table 1. We start by presenting a number of firm characteristics: the profit, the revenue, the total assets, the capital intensity measured by the assets per employee, the age and the apparent labor productivity measured by the value added per employee. Then, we report a number of statistics on the export activities. Note that the participation dummy takes the value of one if the firm is an exporter at a given time, zero otherwise. We infer that firms export in average 2.67 thousands of Euros over the studied period.

Looking at firms' employment, we observe that non-exporters and exporters employ about 96% of natives over their total workforce. Note that about 76.29% of firms do not employ any foreign worker in the sample. We also see that most foreign-born workers hold low-skilled jobs. On average, exporters tend to hire more skilled foreign workers than non-exporters.

We now focus on the characteristics of firms that employ foreign-born workers, as compared to firms that do not. We plot the distributions of two firm-level characteristics that are generally associated to trade outcomes for these two groups of firms. Figure 1 presents the Kernel distributions of the assets (in log) for both groups. The two distributions are very close and have similar shapes. The distribution of firms employing no foreign worker is slightly on the left with respect to the second distribution. It suggests that firms hiring no foreign worker may be smaller.

The same conclusion is reached when looking at the distributions of the capital intensity shown in Figure 2. In this case, the two distributions are hardly distinguishable. Although not reported in the paper, we obtain similar pictures when plotting the debt structure and the

Table 1: Summary statistics

	Obs.	Mean	Std. Dev.	Min.	Max.
FIRM CHARACTERISTICS					
Profit (in thousands of Euros)	5,425,621	0.210	16.722	-14,710	8,099
Revenue (in thousands of Euros)	5,425,621	6.014	597	0	697,523
Assets (in thousands of Euros)	5,425,621	13.860	1,298	0	1,266,449
Capital intensity	5,425,621	83.210	2,323	0	1,265,299
Age (since creation)	4,787,889	16.050	13.220	0	88
Apparent labor productivity	5,425,621	60.910	6,688	0	1.35E+07
TRADE					
Exported value (in thousands of Euros)	1,043,790	3,218	71,816	0	1.51E+07
Exported quantity	1,043,790	1,762	43,028	0	8,766,293
Export destinations	1,043,790	5.960	10.170	1	174
Exported products	1,043,790	22.400	102.195	1	10,194
Participation dummy	4,603,472	0.049	0.217	0	1
EMPLOYMENT PER TYPE OF FIRM					
Panel A: Exporters					
Share of French workers	748,160	0.958	0.145	0	1
Share of foreign-born workers	748,160	0.041	0.145	0	1
Panel B: Non-exporting firms					
Share of French workers	4,603,472	0.961	0.136	0	1
Share of foreign-born workers	4,603,472	0.038	0.018	0	1
SKILLED EMPLOYMENT PER TYPE OF FIRM					
Panel A: Exporters					
Share of French skilled workers	748,160	0.165	0.311	0	1
Share of foreign-born skilled workers	748,160	0.008	0.071	0	1
Panel B: Non-exporting firms					
Share of French skilled workers	4,603,472	0.077	0.213	0	1
Share of foreign-born skilled workers	4,603,472	0.004	0.045	0	1

employment of the firms. Thereby, the two groups of firms do not seem to be very different when we look at variables related to their balance-sheet.

Figure 1: Distributions of assets by types of firms

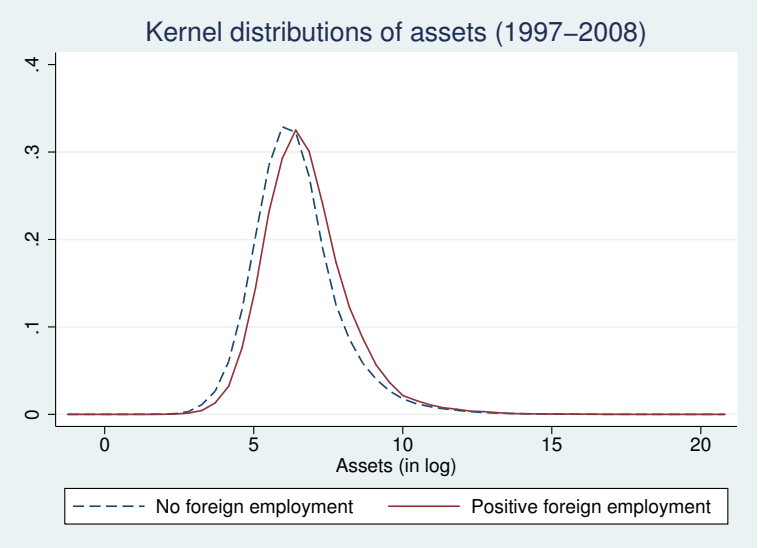


Figure 2: Distributions of the capital intensity by types of firms

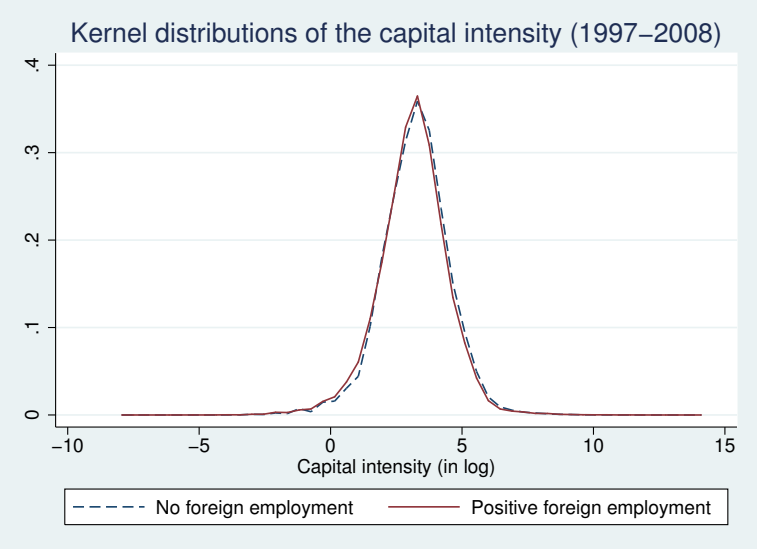
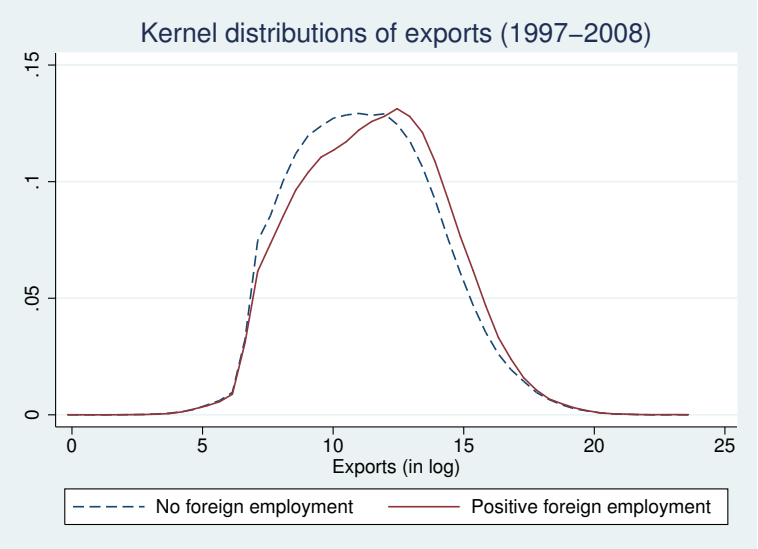


Figure 3 shows the distributions of the exports (in log) at the firm-year level. Contrarily to previous dimensions, the two distributions seem to be distinct. The distribution of firms employing no foreign worker is slightly on the left with respect to the distribution of firms employing foreign workers. The shapes of the two distributions also seems to be distinct. On average, firms that employ foreign-born workers seem to export substantially more.

Figure 3: Distributions of total exports by types of firms



If the two types of firms are not different on average, except in their export outcomes, it gives a rationale to compare two firms that only differ in their foreign employment to identify the effect of foreign workers on exports. In that case, the comparison is less likely to be flawed and biased by firm size or firm performance, which do not seem on average to be correlated with foreign employment. This aggregate information is an additional support for the following theoretical analysis based upon first-order selection effects. It also supports the following empirical strategy, which consists in comparing trade outcomes from firms that only differ in their foreign employment.

4 The theoretical framework

In this section, we use a model of heterogeneous firms in monopolistic competition *à la* Melitz (2003), to illustrate the different channels through which foreign employment can impact trade. In our framework, firms are heterogeneous in their productivity level and in their employment of foreign workers. Analyzing first-order selection effects, we show how foreign employment determines the choice of a firm to supply a foreign market, and how it allows that firm to produce larger quantities for each foreign market it supplies.

4.1 Model set-up

Consider a world with $n+1$ symmetric countries open to trade: a domestic country denoted d and n foreign countries indexed by j.

Each country is endowed with a stock of composite labor denoted L. Following Borjas (2003), this composite labor is a CES aggregate made of native and foreign-born workers who

are imperfect substitutes:

$$L = \left[\sum_{o} \theta^{o} \left(L^{o} \right)^{\frac{\delta-1}{\delta}} \right]^{\frac{\delta}{\delta-1}} \; ; \; \forall o = \{d, m\} \tag{1}$$

The superscript o denotes the origin country of the workers, where d refers to *domestic-born* and m refers to *foreign-born*. θ^{o} represents the origin-specific productivity level of the workers, and δ is a positive constant denoting the elasticity of substitution between the two groups of workers. We further assume that foreign workers, disregarding their country of birth, are perfect substitutes.

Workers are paid at their marginal productivity, and the wage of one unit of labor composite factor equals unity which ensures the factor price equalization among countries.

In each country, we consider a continuum of firms producing with the composite labor and operating under monopolistic competition. Thus, the number of firms also equals the number of varieties produced in the country. Each firm faces the following demand function on each market:

$$q = Q \left(\frac{p}{P} \right)^{-\sigma} \tag{2}$$

where σ denotes the elasticity of substitution between any two varieties, p is the price of the firm's variety, Q is the aggregate set of varieties consumed as an aggregate good and P is the associated aggregate price.

4.2 The firm's productivity

Each firm is characterized by a productivity level given by $\varphi = \phi\alpha$. φ is composed of an *exogenous* productivity drawn from a random distribution and denoted ϕ, and an *endogenous* productivity denoted α. The latter depends on the workforce composition of the firm and is given by $\alpha = a(\lambda_1, ..., \lambda_n)$ where λ_j denotes the share of workers born in country j employed by the firm.[2] a is defined over $[0, 1]^n$. It is symmetric and concave in its arguments such that there exists an optimum of the workforce composition that maximizes the endogenous productivity of the firm.

The firm selects the composition of its workforce in order to maximize its productivity (φ). The employment of an additional foreign workers always increases the firm's endogenous productivity:

$$\frac{\partial \alpha}{\partial \lambda_j} \geq 0 \, \forall j \tag{3}$$

Here, allowing the derivative to equal zero, we account for non-linearity in the effect of foreign employment size on the firm productivity. Then, allowing the derivative to be positive, we consider that firms are constrained by the scarcity of foreign workers on the labor market, so

[2] We consider that $\lambda_d + \sum_{j=1}^{n} \lambda_j = 1$ where λ_d denotes the share of natives employed by the firm.

their employment of foreign workers is always sub-optimal. This assumption makes especially sense for France, where the share of foreign-born workers is rather small over the 1997-2008 period.

Yet, even under foreign labor scarcity, condition (3) may not hold for all firms. Firms may face different costs to hire a foreign employee. For some of them, the costs may be so high that it would penalize their productivity. Consequently, a firm that employs no foreign worker either faces factor scarcity, or does not meet condition (3). In this theoretical framework, we only consider firms that can benefit from foreign employment.

Finally, because foreign workers are perfect substitutes, the firm has no intrinsic preference regarding their origin countries. The set of foreign workers it hires depends on a stochastic process. Firms are therefore heterogeneous in their employment of foreign workers born in a specific foreign country.

4.3 Export to market j

The technology of the firm to produce q_j units of goods for a foreign market j is given by:

$$c_j = \frac{\tau_j}{\varphi} q_j + f_j \tag{4}$$

where τ_j denotes an *ad valorem* cost greater than unity and f_j denotes a positive fixed cost. Both export costs are firm- and destination-specific, thus the firm may not export toward all foreign destinations.

We consider that foreign workers born in a country j decrease both export costs toward that destination, so that $\partial\tau_j/\partial\lambda_j \leq 0$ and $\partial f_j/\partial\lambda_j \leq 0$. Here, we assume that foreign workers convey valuable information about their origin country, which eventually allows their firm to overcome trade barriers for that destination. In addition, we assume that $\partial\tau_j/\partial\lambda_{j'} \leq 0$ and $\partial\tau_j/\partial\lambda_j \leq \partial\tau_j/\partial\lambda_{j'}$, and that $\partial f_j/\partial\lambda_{j'} \leq 0$ and $\partial f_j/\partial\lambda_j \leq \partial f_j/\partial\lambda_{j'}$. Doing so, we consider that foreign workers may have a general knowledge of foreign markets that allows them to lower export costs toward other destinations, yet to a lower extent. Finally, allowing these derivatives to equal zero, we account for non-linearity in the effect of foreign employment size on the firm export costs. It relates the idea that the information brought by the first foreign worker hired by the firm may be more important than the information brought by the last one.

Profit maximization gives the quantity offered by the firm on market j:

$$q_j = Q\left[P\left(\frac{\sigma-1}{\sigma}\right)\frac{\varphi}{\tau_j}\right]^{\sigma} \tag{5}$$

and its *ex-post* profit:

$$\pi_j = \frac{R}{\sigma}\left[P\left(\frac{\sigma-1}{\sigma}\right)\frac{\varphi}{\tau_j}\right]^{\sigma-1} - f_j \tag{6}$$

4.4 First-order selection effects

We now study the emergence of first-order selection effects.[3] We consider that firms are small enough to have no impact on the general equilibrium, which allows us to study whether differences in foreign employment induce differences in export behaviors or not. The theoretical predictions of the model detailed hereafter are summarized in Table 2.

Table 2: Impacts of foreign workers on their firm's export performance

	endogenous productivity α	variable cost τ_j	fixed cost f_j
Extensive margin			
$\mathrm{d}\Pr(\pi_j \geq 0)/\mathrm{d}\lambda_j$	+	+	+
$\mathrm{d}\Pr(\pi_j \geq 0)/\mathrm{d}\lambda_{j'}$	+	+	+
Intensive margin			
$\partial q_j/\partial\lambda_j$	+	+	0
$\partial q_j/\partial\lambda_{j'}$	+	+	0

4.4.1 Effect of foreign employment on the extensive margin

Proposition 1. *The profit of a firm realized on a foreign market j is given by $\pi_j(\phi, \lambda_1, ..., \lambda_n)$. Due to the existence of a positive entry cost on market j (f_j), the zero-profit condition implicitly defines a firm-specific threshold function for market j that can be written as $\psi_j(\phi, \lambda_1, ..., \lambda_n)$.*

Proposition 2. *The higher the exogenous productivity of a firm, the higher its probability to match market j's entry threshold: $\partial\psi_j/\partial\phi < 0$.*

Proof. The firm's probability to serve market j can be rewritten as $\Pr(\pi_j \geq 0)$. This probability positively depends on the firm's exogenous productivity as shown by the following equation:

$$\frac{\partial\pi_j}{\partial\phi} = \frac{\sigma-1}{\sigma}R\left[P\left(\frac{\sigma-1}{\sigma}\right)\frac{\alpha}{\tau_j}\right]^{\sigma-1}\phi^{\sigma-2} > 0 \tag{7}$$

□

Proposition 3. *The more foreign workers a firm hires, the higher its probability to enter market j: $\partial\psi_j/\partial\lambda_j < 0\,\forall j$.*

[3] We are able to study first-order selection effects because we assume that a general equilibrium exists and because the firm's profit is continuous and decreasing in the marginal cost (Mrázová and Neary, 2013). Mrázová and Neary (2013) explain that an equilibrium exist in any general model of monopolistic competition. This is likely to be the case for our framework since its structure is similar to the model of Melitz (2003). We depart from this seminal paper by considering two sources of heterogeneity: firms are not only heterogeneous in their productivity level but also in their employment of foreign workers. Thus, in our framework, export cutoffs are firm- *and* destination-specific.

Proof. The probability to enter market j positively depends on the firm's employment of foreign workers born in country j, since:

$$\frac{\partial \pi_j}{\partial \lambda_j} = \frac{\sigma-1}{\sigma} R \left[P \left(\frac{\sigma-1}{\sigma} \right) \right]^{\sigma-1} \left(\frac{\varphi}{\tau_j} \right)^{\sigma-2} \left(\frac{\partial \varphi}{\partial \lambda_j} \tau_j - \varphi \frac{\partial \tau_j}{\partial \lambda_j} \right) \frac{1}{(\tau_j)^2} - \frac{\partial f_j}{\partial \lambda_j} > 0 \quad (8)$$

For a given exogenous productivity (ϕ), a marginal increase in the share of foreign workers from country j increases the firm's productivity. In addition, it reduces the firm's export costs toward that market.

The firm's profit on market j also increases with its employment of foreign workers coming from another country (j'), but in lower proportions:

$$\frac{\partial \pi_j}{\partial \lambda_j} \geq \frac{\partial \pi_j}{\partial \lambda_{j'}} \quad (9)$$

□

4.4.2 Effect of foreign employment on the intensive margin

Proposition 4. *The more foreign workers a firm hires, the higher its exported quantity toward market j.*

Proof. The firm's export quantity toward market j is given by $q_j(\phi, \lambda_1, ..., \lambda_n)$. As shown below, it positively reacts to the employment of foreign workers coming from country j:

$$\frac{\partial q_j}{\partial \lambda_j} = \sigma Q \left[P \left(\frac{\sigma-1}{\sigma} \right) \right]^{\sigma} \left(\frac{\varphi}{\tau_j} \right)^{\sigma-1} \left(\frac{\partial \varphi}{\partial \lambda_j} \tau_j - \varphi \frac{\partial \tau_j}{\partial \lambda_j} \right) \frac{1}{(\tau_j)^2} > 0 \quad (10)$$

A marginal increase in the share of foreign workers coming from country j induces an increase in the firm's productivity. In addition, it impacts its variable export costs toward that market.

The firm's exports to market j also increase with its employment of foreign workers coming from another country (j'), but in lower proportions:

$$\frac{\partial q_j}{\partial \lambda_j} \geq \frac{\partial q_j}{\partial \lambda_{j'}} \quad (11)$$

□

5 The export-enhancing effect of foreign-born workers

We now estimate the export-induced effect of foreign-born workers at the firm level. We first argue that our empirical strategy has to account for endogeneity concerns. We then present the PSM strategy we use. We report the results in the last part of this section.

5.1 Endogeneity concerns

In our estimation of the export-enhancing effect of foreign-born workers, the first endogeneity concern relates to the presence of a reverse causality bias. At the aggregate level, immigration depends on host and home country characteristics such as labor market conditions, that in turn can depend on growth in trade. In addition, the migration rate between two countries depends on the bilateral migration cost. This cost decreases with the level of information available about the destination country, that may be determined by the level of bilateral trade.

At the micro level, causality may run from firm performance to foreign employment decisions. We cannot exclude that firms may favor the employment of foreign workers coming from the destinations with which they already have a trading experience. On the link between foreign employment, export experience and export performance, see Choquette and Meinen (2015) and Minondo (2011). More generally, the export performance of the firm may affect its possibility to attract a certain type of workers, and thus bias the estimation. We could also think that migrant workers may self-select into some types of firms. All these mechanisms generate a potential endogeneity bias regarding the estimation of the pro-trade effect of immigrants.

So far, studies intending to tackle this endogeneity concern have instrumented contemporaneous foreign employment using either the lagged aggregate immigration stocks, the regional/sectoral immigration stocks, or a neighboring country's immigration stocks. However, to use lagged immigration stocks, one needs to assume that the potential reverse causality is not time resistant. To use local immigration stocks, one should assume that the local presence of immigrants is exogenous to the firm's performance, while it has been shown that export-relevant information is not only individual-specific, but is also embedded in the population of immigrants *i.e.* in the firm's environment (Parsons and Winters, 2014). Finally, Hatzigeorgiou and Lodefalk (2016) note that country and/or regional migrant stocks are inadequate proxies of migrants employed in private business.

Due to the difficulty to find an instrument that would be convincing and available at a low level of disaggregation, we implement a PSM strategy. The advantage of this method, over a multivariate regression analysis such as the IV-2SLS framework, is that it allows one to remain agnostic about the firm's decision to hire a foreign workers. Moreover, it allows us to take full advantage of the micro-level data by keeping all information on foreign employment at the firm level.

We acknowledge that the PSM strategy allows us to control for reverse causality because we assume that most of the factors driving the potential endogeneity bias can be observed *i.e.* all variables that may impact foreign employment. The richness of our dataset allows us to believe that selection on unobservables is negligible, and that the PSM approach allows for causal inference. Omitting to control for a relevant variable would generate a second source of endogeneity between foreign employment and unobserved variables. It would also generate a bias due to potential selection effects since firms may be heterogeneous with respect to the gain associated to foreign employment (see discussion in section 4). Finally, the use of this approach is all the more supported by the size of the dataset, that allows us to have a large control group

to operate the matching. While this criterion is less likely to be met when dealing with aggregate data, we are confident that the present data allow us to overcome this difficulty.

5.2 Propensity score matching and treatment effect estimation

To estimate the average treatment effect of employing foreign-born workers on export outcomes, we use the PSM method extensively used in the estimation of treatment effects (Rosenbaum and Rubin, 1983). It allows us to overcome the fact that firms may have different probabilities to employ foreign workers and that these probabilities may be correlated with their export performance.

Let D_{it} denotes a dummy variable which equals 1 if a firm i is *treated*, *i.e.* if it employs at least one foreign worker at time t. Conversely, $D_{it} = 0$ for an *untreated* or a *control* firm i that employs no foreign worker.

Let X_{it}^T denotes the export outcome of firm i at time t when it is part of the treated group, and X_{it}^C when it pertains to the control group. Summing over firms of each group, we are able to observe the following expected values:

$$E[X_{it}^T \mid D_{it} = 1] \tag{12}$$

$$E[X_{it}^C \mid D_{it} = 0] \tag{13}$$

The difference in equations (12) and (13) is made of the *average treatment effect on the treated* (ATT) and a sampling bias:

$$E[X_{it}^T \mid D_{it} = 1] - E[X_{it}^C \mid D_{it} = 0] = \text{ATT} + E\left(X_{it}^C \mid D_{it} = 1\right) - E\left(X_{it}^C \mid D_{it} = 0\right) \tag{14}$$

where:

$$\text{ATT} = E\left[X_{it}^T - \left(X_{it}^C \mid D_{it} = 1\right)\right] \tag{15}$$

We are interested in capturing this ATT. Yet, the ATT is not observable as long as the sampling bias is not nil. The sampling bias is the difference in outcomes that is attributable to differences in the treated and the control groups (such as different firm characteristics) rather than any effect of the treatment itself. Any sampling bias would be straightforward to adjust for if firms differed along a small set of (measurable) dimensions. This is not feasible, however, when comparing firms which vary across a wide number of dimensions.

The PSM method allows to overcome this challenge. This methodology matches treated firms to a subset of untreated firms, based on a set of observable firm characteristics denoted by a vector C_{it}. Rosenbaum and Rubin (1983) show that it is sufficient to match treated and control observations based on a *propensity score*, denoted $p\left(C_{it}\right)$, which is a scalar variable representing the probability that a firm i receives the treatment at time t. The propensity score is given by the conditional probability of firm i to employ foreign-born workers given pre-treatment characteristics:

$$p\left(C_{it}\right) = \text{Prob}\left(D_{it} = 1 \mid C_{it}\right) \tag{16}$$

In practice, we compute the scores by estimating the following equation:

$$D_{it} = \alpha C_{it} + \gamma_i + \gamma_s + \gamma_r + \gamma_t + \varepsilon_{it} \tag{17}$$

which includes firm (γ_i), sector (γ_s), region (γ_r) and year (γ_t) fixed effects. We include firm fixed effects to control for time-invariant firm characteristics that affect the probability to employ foreign-born workers. For instance, we cannot exclude that multinational firms may behave differently from domestic-only firms about the choice of their labor force, resulting in different probabilities of employing foreign-born workers. Also, we cannot exclude that some executive managers may discriminate between native and foreign workers. Sector fixed effects are included to account for unobserved heterogeneity in the employment of foreign-born workers which may be favored in one particular sector, possibly because of skill requirements.

Since the dependent variable in equation (17) is a binary variable, standard practice consists in using a logit estimator. However, insofar as fixed effects are crucial here, we estimate equation (17) using an OLS estimator allowing us to add a full set of fixed effects. We check that the predictive values for the score do not depart from the (0,1) support. In all specifications, we find that the estimated score is out of the (0,1) range for less than 0.05% of the observations, which we then drop from the sample. We perform some robustness checks using a logit estimation without any fixed effect.

Once the propensity scores are estimated, we match each treated firm with the non-treated firm that has the closest propensity score. We then estimate the average treatment effect (equation 15) as follows:

$$\text{ATT} = E\left[X_{it}^{T} \mid D_{it} = 1, p\left(C_{it}\right) - X_{it}^{C} \mid D_{it} = 0, p\left(C_{it}\right)\right] \tag{18}$$

Equation (18) gives the change in export outcomes due to the employment of foreign workers, after controlling for selection bias in foreign employment. The identification comes from the differences in export outcomes between matched firms, that is between firms having very close probabilities to employ foreign-born workers but which are actually different in their foreign employment.

Finally, to assess the quality of the matching method and thereby the quality of the ATT estimate, we check that, on average and after matching, treated and control firms have similar characteristics.

5.3 Results

We estimate the ATT of employing foreign-born workers on different export outcomes: the export value and the export quantity for the intensive margin, the number of destinations served, the number of HS6 products exported and the probability to export (participation dummy) for the extensive margin.

We start by estimating the probability to be treated – to employ of a positive number of foreign-born workers at time t – for each firm-year observation. At first, we estimate this

probability following equation (17) and using an OLS estimator. Covariates (C_{it}) include firm size proxies, financial characteristic variables and firm-level hierarchy measures. More especially, in the administrative employer-employee dataset, each worker is assigned a CS1 and a CS2 code that are respectively 1-digit and 2-digit socio-professional categories. We compute the firm-level count of 1- and 2-digit categories, and the Herfindahl index of concentration of all workers in these categories. The results of this first-step estimation are presented in the Appendix, in Table 9, column (1). From this estimation, we predict the propensity scores.

We then match each treated firm with a control firm having the closest score, and that belong to the same sector-region pair. Doing so, we investigate whether variations in foreign employment, within a local labor market, are associated to different export outcomes. Baseline results are presented in Table 3, in which we report the estimated ATT, the standard error in parentheses.

Column (1) presents the estimated ATT estimates. We find that both margins of trade react positively and significantly to the treatment. At the intensive margin, we find that firms employing foreign workers export larger values and larger quantities. On average, a firm employing foreign-born workers exports 30% ($e^{0.270}$) more in value and 39% ($e^{0.330}$) more in volume over all its destinations, than a control firm having the same probability to employ foreign workers but that does not. At the extensive margin, the participation dummy positively reacts to foreign employment: treated firms are more frequently exporters than control firms. We also estimate that firms employing foreign workers export a larger set of products toward a larger set of destinations than firms that only employ native workers.

To control for the quality of the matching method, we check that the post-matching groups have similar characteristics. In Table 4, we present the average values of variables used to compute the scores for the treated and non-treated observations. We also present the relative bias measure, instead of the t-test based comparison (Austin, 2009), to support that the inference made using propensity-score matching is valid. Table 4 suggests that treated firms are not different, on average, from control firms. This is consistent with aggregate evidence provided in Section 3.2, suggesting that firms employing foreign workers were not different from firms that do not. This set of evidence suggests that comparing firms in this dimension makes sense and supports the strategy consisting in attributing differences in export performance to the employment of foreign-born workers. All the results presented hereafter are based upon comparable post-matching group characteristics that we do not report for sake of space.

We then investigate the effect associated to alternative treatments. In Table 3, column (2), we present the estimated ATT of an increase in foreign employment between time $t-1$ and time t. Column (3) presents the estimated ATT of an increase in foreign employment between time $t-1$ and time t, conditional upon having a positive foreign employment at time $t-1$. Doing so, we investigate the pro-trade effect of an increased foreign employment, and whether this effect is concentrated on the first foreign-born worker hired. In other words, when a firm starts employing foreign workers, all trade margins should be positively affected. On the contrary, when a firm

already employed foreign-born workers, the effect could be smaller or absent because it excludes the effect of the first foreign worker employed.

We find clear-cut evidence supporting a pro-trade effect of an increase in foreign employment at any margin: all coefficients in column (2) are significantly positive, suggesting that increasing foreign employment generates a pro-trade effect. However, when we control for previous foreign employment, in column (3), we find a small positive effect at the intensive margin, and a small positive effect on the export participation. We also estimate that the number of destinations and the number of products exported do not react to additional foreign employment. We infer from this set of results that additional foreign-born workers generate a positive but lower pro-trade effect as compared to the first foreign worker employed by the firm.

We replicate the same estimations differentiating skilled from unskilled workers, to investigate whether the effect of foreign-born workers could be driven by skilled workers only. Results are presented in Table 3, in columns (4) to (9). Point estimates suggest that skilled foreign workers generate an export-enhancing effect that seems to be quantitatively larger as compared to unskilled foreign workers. Both trade margins are positively affected by the employment (column 4) and by an increase of skilled foreign workers (column 5). Looking at column (6), wee see that the pro-trade effect of an increase in skilled foreign employment is restricted to the first foreign employee hired by the firm. We do not find evidence supporting a pro-trade effect, at any margin, of an increased foreign employment once conditioned upon positive previous foreign employment. By contrast, columns (7) to (9) estimate a significant and positive effect associated to the employment of unskilled foreign workers, which is not restricted to the first foreign employee. Yet, this export-enhancing effect is smaller than for skilled foreign workers.

We infer from this set of results that both skilled and unskilled workers are driving the average export-enhancing effect of foreign employment at the firm level. The results on the pro-trade effect for unskilled foreign workers, that are less supposed to bring information to their firms, is one contribution of this paper since we can rationalize it through a productivity effect that should affect all trade margins. We interpret this result as evidence supporting the existence of a productivity channel. Most existing papers emphasize that the pro-trade effect of immigrants only occurs through the informational channel, that is hardly compatible with such an export-enhancing effect for unskilled workers. To the best of our knowledge, Mitaritonna et al. (2016) are the first to explicitly analyze the productivity-enhancing effect of immigrants, yet their analysis focuses mainly on skilled foreign workers.

Table 3: Average Treatment Effect estimates - Baseline results

Treatment (D_{it})	(1) $M_{it} > 0$	(2) $M_{it} > M_{it-1}$	(3) $M_{it} > M_{it-1}$ $M_{it-1} > 0$	(4) $M^S_{it} > 0$	(5) $M^S_{it} > M^S_{it-1}$	(6) $M^S_{it} > M^S_{it-1}$ $M^S_{it-1} > 0$	(7) $M^U_{it} > 0$	(8) $M^U_{it} > M^U_{it-1}$	(9) $M^U_{it} > M^U_{it-1}$ $M^U_{it-1} > 0$
Propensity score estimator	OLS								
Matching algorithm	Closest neighbor								
Matching constraint	Same region-sector								
	Intensive Margin								
Export Value	0.270^a	0.242^a	0.112^a	0.418^a	0.283^a	0.210^b	0.265^a	0.261^a	0.154^a
	(0.029)	(0.029)	(0.043)	(0.035)	(0.041)	(0.102)	(0.031)	(0.031)	(0.047)
Export Quantity	0.330^a	0.262^a	0.115^b	0.411^a	0.293^a	0.066	0.344^a	0.302^a	0.212^a
	(0.037)	(0.036)	(0.053)	(0.044)	(0.052)	(0.124)	(0.039)	(0.038)	(0.057)
	Extensive Margin								
Nr. of Destinations	0.079^a	0.092^a	0.014	0.138^a	0.082^a	0.035	0.076^a	0.094^a	0.054^a
	(0.012	(0.012)	(0.018)	(0.016)	(0.017)	(0.042)	(0.013)	(0.013)	(0.020)
Nr. of Products	0.113^a	0.132^a	0.039	0.194^a	0.127^a	0.058	0.114^a	0.144^a	0.075^a
	(0.017)	(0.016)	(0.025)	(0.020)	(0.024)	(0.057)	(0.018)	(0.017)	(0.027)
Participation Dummy	0.015^a	0.017^a	0.009^a	0.017^a	0.013^a	0.002	0.014^a	0.019^a	0.009^a
	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)	(0.007	(0.002)	(0.002)	(0.003)

Note: This table provides the ATT estimates for the five dependent variables. All trade margins measures are in logarithm, except the participation dummy. Propensity scores upon which the matching is made are computed using predictions from the estimation of equation (17). M_{it}, M^S_{it} and M^U_{it} respectively denote the share of foreign, skilled foreign and unskilled foreign workers in firm i at time t. We match firms using the estimated propensity scores from the same region-sector. Robust standard errors are shown in parentheses. ^{a}, ^{b} and ^{c} respectively denote significance at the 1%, 5% and 10% levels.

Table 4: Matching quality - Baseline results

Treatment (D_{it})	$M_{it} > 0$		
Propensity score estimator	OLS		
Matching algorithm	Closest Neighbor		
Matching constraint	Same region-sector		
	Treated	Control	% bias
Mean Age of Workers	3.61	3.61	0.01
Nr. of CS1	1.07	0.99	0.16
Nr. of CS2	1.89	1.72	0.22
Herf. CS1	-0.52	-0.51	-0.03
Herf CS2	-1.33	-1.29	-0.12
Nb of skilled workers	1.88	1.65	0.24
Firm Age	2.85	2.84	0.02
Employment	3.62	3.49	0.09
Assets	8.61	8.49	0.08
Own resources	0.09	0.09	0.09

Note: This table provides the observed means of firm characteristics (C_{it}) for the treated and the control groups after score matching and computation of the ATT on the export value. All variables are in logarithm and lagged $(t-1)$. M_{it} denotes the share of foreign workers in firm i at time t. We compare the two means using a relative bias measures, relating the quality of the matching procedure. *% bias* denotes the normalized relative bias between the two means; see Austin (2009).

To compute the baseline results, we use two sources of variations to identify the export-enhancing effect of foreign workers. Since we estimate the impact of foreign employment on firm-year export performance measures, the total variation may come from variations across firms for a given year and across years for a given firm. In line with our theoretical model, we now explicitly focus on the effect of variation in foreign employment across firms for a given year. To do so, we now match treated and control firms within the same region-sector-year triplet.

Table 5 presents the estimation results for the same treatments as before but including this additional constraint in the matching. When looking at the variation in the export performance of two matched firms in the same year, we find that all trade margins are positively affected by the employment of foreign workers. The pro-trade effect of an increased foreign employment conditional upon a positive foreign employment in $t-1$, is now positive and significant (columns 3 and 6). As can be noted from the characteristics of the treated and control firms in Table 6, the matching quality is however lower than for the baseline estimation.

Table 5: Average Treatment Effect estimates - Within-year results

Treatment (D_{it})	(1) $M_{it} > 0$	(2) $M_{it} > M_{it-1}$	(3) $M_{it} > M_{it-1}$ $M_{it-1} > 0$	(4) $M^S_{it} > 0$	(5) $M^S_{it} > M^S_{it-1}$	(6) $M^S_{it} > M^S_{it-1}$ $M^S_{it-1} > 0$	(7) $M^U_{it} > 0$	(8) $M^U_{it} > M^U_{it-1}$	(9) $M^U_{it} > M^U_{it-1}$ $M^U_{it-1} > 0$
Propensity score estimator	OLS								
Matching algorithm	Closest neighbor								
Matching constraint	Same region-sector-year								
	Intensive Margin								
Export Value	0.242^a	0.304^a	0.215^a	0.471^a	0.484^a	0.513^a	0.191^a	0.276^a	0.183^a
	(0.024)	(0.028)	(0.042)	(0.034)	(0.040)	(0.098)	(0.026)	(0.030)	(0.047)
Export Quantity	0.314^a	0.316^a	0.262^a	0.446^a	0.455^a	0.425^a	0.294^a	0.324^a	0.264^a
	(0.031)	(0.035)	(0.052)	(0.038)	(0.051)	(0.120)	(0.033)	(0.037)	(0.056)
	Extensive Margin								
Nr. of Destinations	0.068^a	0.104^a	0.051^a	0.145^a	0.152^a	0.110^b	0.046^a	0.097^a	0.043^b
	(0.010)	(0.012)	(0.018)	(0.013)	(0.017)	(0.042)	(0.011)	(0.013)	(0.019)
Nr. of Products	0.101^a	0.157^a	0.081^a	0.211^a	0.232^a	0.178^a	0.073^a	0.156^a	0.080^a
	(0.015)	(0.016)	(0.025)	(0.017)	(0.023)	(0.056)	(0.015)	(0.017)	(0.026)
Participation Dummy	0.017^a	0.021^a	0.013^a	0.023^a	0.024^a	0.020^a	0.016^a	0.022^a	0.015^a
	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)	(0.007)	(0.002)	(0.002)	(0.003)

Note: This table provides the ATT estimates for the five dependent variables. All trade margins measures are in logarithm, except the participation dummy. Propensity scores upon which the matching is made are computed using predictions from the estimation of equation (17). M_{it}, M^S_{it} and M^U_{it} respectively denote the share of foreign, skilled foreign and unskilled foreign workers in firm i at time t. We match firms using the estimated propensity scores from the same region-sector-*year* triplet. Robust standard errors are shown in parentheses. ^{a}, ^{b} and ^{c} respectively denote significance at the 1%, 5% and 10% levels.

Table 6: Matching quality - Within-year results

Treatment (D_{it})	$M_{it} > 0$		
Propensity score estimator	OLS		
Matching algorithm	Closest Neighbor		
Matching constraint	Same region-sector-year		
	Treated	Control	% bias
Mean Age of Workers	3.61	3.62	-0.03
Nr. of CS1	1.07	0.99	0.35
Nr. of CS2	1.89	1.65	0.45
Herf. CS1	-0.52	-0.49	-0.09
Herf. CS2	-1.31	-1.17	-0.28
Nr. of skilled workers	1.88	1.40	0.45
Firm Age	2.86	2.85	0.02
Employment	3.62	3.42	0.14
Assets	8.61	8.43	0.11
Own resources	0.09	0.09	0.01

Note: This table provides the observed means of firm characteristics (C_{it}) for the treated and the control groups after score matching and computation of the ATT on the export value. All variables are in logarithm and lagged ($t-1$). M_{it} denotes the share of foreign workers in firm i at time t. We compare the two means using a relative bias measures, relating the quality of the matching procedure. *% bias* denotes the normalized relative bias between the two means; see Austin (2009).

5.4 Robustness checks

We perform a number of robustness checks to address potential bias and alternative mechanisms that could affect our estimation of the pro-trade effect of foreign employment. All robustness tests tend to confirm the existence of an export-enhancing effect of foreign workers at the firm-level.

Additional constraints in the matching procedure

We start by using an alternative matching procedure: we match treated and untreated firms within the same sector-region pair, and that belong to the same (contemporaneous) import growth quartile. Firm choices about imported inputs, such as input sourcing or input costs, are known to affect firm performance and thus export outcomes. We cannot exclude that the pro-trade effect of foreign-born workers may occur through an import channel that would then affect export outcomes. We exclude this potential channel in our estimation by matching treated and control firms upon the same import growth quartile during the year of the treatment. ATT results are displayed in Appendix, Table 10, and the matching quality can be inferred from first

set of columns in Table 11 and suggests comparable post-matching firm characteristics for both groups of firms.

ATT results in Table 10 are very close to the baseline estimates. We find a pro-trade effect that resists to the inclusion of import growth at the firm level. We estimate a positive pro-trade effect of employing foreign workers and of increasing foreign employment. The pro-trade effect is not restricted to the first foreign worker or to skilled foreign workers, even though additional skilled foreign workers are not associated to any trade effect at the extensive margin.

We also match treated and untreated firms within the same sector-region pair, and that belong to the same (pre-treatment) export growth quartile. We thus compare firms that were on the same export growth path before being treated, in $t-1$. This strategy allows us to further control for the presence of a reverse causality bias. Note that as we condition the treatment upon pre-treatment export growth, we cannot estimate the impact of foreign employment on the export participation. ATT results are displayed in Appendix, Table 12. All trade margins are significantly and positively associated to foreign employment and particularly skilled foreign employment. In columns (2) and (3), we find that the estimated ATT of increasing foreign employment between time $t-1$ and time t has a positive and significant impact on both trade margins, even though additional foreign workers are not associated to any trade effect.

The quality of the matching procedure for the export value can be inferred from the second set of columns in Table 11 (in Appendix) and suggests pretty comparable post-matching firm characteristics for both groups of firms. Yet, we find a lower matching quality since the relative biases are on average higher than for the baseline evidence. Including the additional constraint on pre-treatment export growth in the matching process indeed seems to generate a systematic bias, that alters the comparability of export outcome across the two groups of firms.

Alternative matching procedure

We also match each treated firm with its 5 non-treated closest neighbors in propensity scores. ATT results are displayed in Appendix, Table 13. Baseline coefficients are confirmed, but the precision is slightly lower relatively to the baseline estimates. This is consistent with the increase in the relative biases in the matching procedure that the third set of Table 11 reports.

Alternative estimator for the propensity scores

We finally test the robustness of our results using an alternative estimator for the propensity scores. We estimate the probability to be treated upon the same covariates as previously, but we use a logit estimator and we exclude the structure of fixed effects due to computational difficulties resulting from the sample size. First-step estimation results are presented in Appendix, Table 9, column (2). The estimated ATT using scores computed from a logit estimation are presented in Appendix, Table 14. We estimate similar patterns for the pro-trade effect of foreign workers than in the baseline estimation. Yet, the quality of the matching process appears to be lower

than for the previous estimations as we can see from the high relative bias measures displayed in the last set of columns in Table 11.

6 Beyond the destination-specific effect of foreign workers

One important result from the previous section shows that foreign workers favor exports at both margins. In contrast to most of the literature, we estimate an export-enhancing effect of foreign employment at the intensive margin. To further explore this results, we now investigate whether an increase in foreign employment fosters exports to all destinations for a given firm. To do so, we use additional information from the customs dataset. We exploit variations in exports across destinations for a given firm-year observation as a source of identification to provide further support to the pro-trade effect of foreign workers at the intensive margin.

The objective of this section is twofold. First, it allows us to support that the effect of foreign workers on exports is not only destination-specific. Variations in exports across destinations are informative on whether foreign-born workers favor exports toward all destinations, or whether they skew exports toward a smaller set of countries. Second, we want to address some potential compositional effects that may affect our measure of the intensive margin. The firm-year export value may be flawed by aggregation bias across destinations. Consider a firm exporting a given value to country j at time $t-1$. At time t, the firm exports the same value to j, and enters destination h. Because of export aggregation, both trade margins are affected in t, while exports in j remain constant. Thus, aggregate data are not fully informative. We address this issue by exploring variations of exports across destinations.

6.1 Controlling for firm-destination-year shocks in exports

A robust measure of the intensive margin requires to control for firm-destination-year shocks in exports, such as entry, exit and changes in the destination portfolio. By purging firm-destination-year exports from idiosyncratic shocks at the firm, destination and year level, we recover variations that are common across destinations for a given firm and thus measures more carefully the intensive margin.

We estimate the following equation with an OLS estimator:

$$X_{ijt} = \gamma_{it} + \gamma_{ij} + \gamma_{jt} + \epsilon_{ijt} \tag{19}$$

where X_{ijt} is the exported value by a firm i toward a destination j at time t, where γ_{it} is a firm-year fixed effect and where γ_{ij} and γ_{jt} respectively denote firm-destination and destination-year fixed effects. We recover the estimated γ_{it} and compute the ATT associated to foreign employment on this estimated γ_{it}.

If the pro-trade effect of foreign workers was solely driven by the destination-specific channel, variations at the intensive margin would be absorbed by the firm-destination or destination-year fixed effects. On the contrary, a positive effect of foreign employment on the firm-year fixed effect

would support that variations at the intensive margin are driven by changes in export flows in many destinations simultaneously. We would then infer that foreign employment generates a general export-enhancing effect, across many destinations.

Table 7 provides the estimated ATT of the different treatments on the estimated firm-year fixed effect. Similarly to the previous section, the table displays the different estimation results, considering alternative matching strategies and propensity score estimations.

In the first line, we estimate a significant export-enhancing effect of foreign workers on the estimated firm-year fixed effect. Once accounting for shocks at the firm-destination and at the destination-year level, we estimate that exports remain positively affected by foreign employment. We interpret this result as further evidence that foreign employment increases exports toward all destinations on average. If the destination-specific effect was the only effect at play, the estimated ATT would be driven to 0. On the contrary, we find that the coefficients for all treatments are significant and positive. We thus infer that the export-enhancing effect of foreign workers also occurs at the intensive margin, and not only through a destination-specific channel.

Similarly to the previous section, Table 7 also provides the estimated ATT considering alternative matching strategies: we match pairs of firms within a sector-region-year group to focus solely on within-year variations in exports and foreign employment. We then match pairs per region-sector-import growth quartile, as well as per region-sector and by pre-treatment export growth quartile. We finally focus on a 5-neighbor matching process and match firms using a score computed with a logit estimator. All coefficients are positive and quantitatively close across panels.

Table 7: Average Treatment Effect estimates - Additional results

Treatment (D_{it})	(1) $M_{it} > 0$	(2) $M_{it} > M_{it-1}$	(3) $M_{it} > M_{it-1}$ $M_{it-1} > 0$	(4) $M^S_{it} > 0$	(5) $M^S_{it} > M^S_{it-1}$	(6) $M^S_{it} > M^S_{it-1}$ $M^S_{it-1} > 0$	(7) $M^U_{it} > 0$	(8) $M^U_{it} > M^U_{it-1}$	(9) $M^U_{it} > M^U_{it-1}$ $M^U_{it-1} > 0$
Panel A: OLS score, Closest neighbor, Sector-region match									
$\hat{\gamma_{it}}$	0.136^a	0.122^a	0.102^a	0.186^a	0.142^a	0.115^a	0.128^a	0.129^a	0.097^a
	(0.019)	(0.018)	(0.027)	(0.022)	(0.025)	(0.059)	(0.021)	(0.021)	(0.031)
Panel B: OLS score, Closest neighbor, Sector-region-year match									
$\hat{\gamma_{it}}$	0.122^a	0.159^a	0.187^a	0.231^a	0.220^a	0.331^a	0.096^a	0.161^a	0.174^a
	(0.016)	(0.018)	(0.027)	(0.018)	(0.025)	(0.057)	(0.017)	(0.020)	(0.030)
Panel C: OLS score, Closest neighbor, Sector-region-import growth quartile match									
$\hat{\gamma_{it}}$	0.136^a	0.115^a	0.133^a	0.233^a	0.165^a	0.268^a	0.116^a	0.095^a	0.107^b
	(0.028)	(0.031)	(0.041)	(0.032)	(0.038)	(0.071)	(0.028)	(0.034)	(0.046)
Panel D: OLS score, Closest neighbor, Sector-region-export growth quartile match									
$\hat{\gamma_{it}}$	0.144^a	0.135^a	0.154^a	0.236^a	0.158^a	0.186^a	0.111^a	0.136^a	0.124^a
	(0.017)	(0.018)	(0.027)	(0.019)	(0.025)	(0.058)	(0.018)	(0.020)	(0.031)
Panel E: OLS score, 5-neighbor , Sector-region match									
$\hat{\gamma_{it}}$	0.154^a	0.155^a	0.161^a	0.238^a	0.194^a	0.253^a	0.125^a	0.145^a	0.138^a
	(0.014)	(0.014)	(0.022)	(0.016)	(0.020)	(0.045)	(0.015)	(0.016)	(0.024)
Panel F: Logit score, Closest neighbor, Sector-region match									
$\hat{\gamma_{it}}$	0.187^a	0.108^a	0.145^a	0.183^a	0.140^a	0.131^a	0.186^a	0.124^a	0.149^a
	(0.019)	(0.018)	(0.027)	(0.021)	(0.025)	(0.058)	(0.019)	(0.020)	(0.030)

Note: This table provides the ATT estimates for the estimated firm-year fixed effect ($\hat{\gamma_{it}}$) in equation (19). Propensity scores upon which the matching is made are computed using predictions from the estimation of equation (17). M_{it}, M^S_{it} and M^U_{it} respectively denote the share of foreign, skilled foreign and unskilled foreign workers in firm i at time t. Robust standard errors are shown in parentheses. ^{a}, ^{b} and ^{c} respectively denote significance at the 1%, 5% and 10% levels.

6.2 Corollary: Concentration of exports across destinations

To support the prevalence of a general effect of foreign employment, we estimate the effect of foreign workers on the concentration of exports across destinations for a given firm-year. Our previous results suggest that foreign workers tend to increase exports over all destinations, that should not result in a higher concentration of exports across destinations. We thus estimate the ATT of foreign employment on the Herfindahl index of exports and check that foreign employment does not increase the concentration of exports, that would prevail if foreign workers only had a destination-specific effect.

Table 8 provides the estimated ATT of the different treatments on the firm-year Herfindahl index of exports, thus replicating the structure of Table 7. We never estimate a positive impact of foreign employment on the concentration of exports. Firms employing foreign workers always exhibit a lower Herfindahl index of exports than control firms. We interpret this as corollary evidence in favor of the general effect of foreign employment on the intensive margin. All in all, this set of results supports that employing foreign workers favors exports toward all destinations. This result is a contribution to the existing literature that extensively focuses on the destination-specific informational channel.

Table 8: Average Treatment Effect estimates - Additional results

Treatment (D_{it})	(1) $M_{it} > 0$	(2) $M_{it} > M_{it-1}$ $M_{it-1} > 0$	(3) $M_{it} > M_{it-1}$	(4) $M^S_{it} > 0$	(5) $M^S_{it} > M^S_{it-1}$	(6) $M^S_{it} > M^S_{it-1}$ $M^S_{it-1} > 0$	(7) $M^U_{it} > 0$	(8) $M^U_{it} > M^U_{it-1}$	(9) $M^U_{it} > M^U_{it-1}$ $M^U_{it-1} > 0$
	Panel A: OLS score, Closest neighbor, Sector-region match								
Herfindahl	-0.019^b	-0.026^a	0.002	-0.037^a	-0.025^a	-0.014	-0.010	-0.019^b	0.001
	(0.009)	(0.008)	(0.012)	(0.010)	(0.011)	(0.027)	(0.009)	(0.009)	(0.014)
	Panel B: OLS score, Closest neighbor, Sector-region-year match								
Herfindahl	-0.007	-0.037^a	-0.010	-0.042^a	-0.053^a	-0.042^a	-0.059^a	-0.033^a	-0.006
	(0.007)	(0.008)	(0.012)	(0.008)	(0.011)	(0.026)	(0.012)	(0.008)	(0.014)
	Panel C: OLS score, Closest neighbor, Sector-region-import growth quartile match								
Herfindahl	-0.019^b	-0.040^a	-0.036^c	-0.060^a	-0.056^a	-0.062^b	-0.009	-0.023	-0.009
	(0.009)	(0.014)	(0.019)	(0.015)	(0.017)	(0.033)	(0.012)	(0.015)	(0.021)
	Panel D: OLS score, Closest neighbor, Sector-region-export growth quartile match								
Herfindahl	-0.016^b	-0.038^a	0.002	-0.045^a	-0.034^a	-0.003	-0.007	-0.022^b	0.015
	(0.008)	(0.008)	(0.012)	(0.009)	(0.011)	(0.027)	(0.008)	(0.009)	(0.014)
	Panel E: OLS score, 5-neighbor , Sector-region match								
Herfindahl	-0.012^c	-0.039^a	-0.009	-0.025^a	-0.045^a	-0.023	-0.001	-0.026^a	0.003
	(0.006)	(0.006)	(0.010)	(0.007)	(0.009)	(0.021)	(0.006)	(0.007)	(0.010)
	Panel F: Logit score, Closest neighbor, Sector-region match								
Herfindahl	-0.038^a	-0.025^a	-0.015	-0.037^a	-0.031^a	-0.004	-0.022^a	-0.013	0.002
	(0.008)	(0.008)	(0.012)	(0.009)	(0.011)	(0.027)	(0.007)	(0.008)	(0.013)

Note: This table provides the ATT estimates for the Herfindahl index of concentration of exports for a given firm-year. Propensity scores upon which the matching is made are computed using predictions from the estimation of equation (17). M_{it}, M^S_{it} and M^U_{it} respectively denote the share of foreign, skilled foreign and unskilled foreign workers in firm i at time t. Robust standard errors are shown in parentheses. ^{a}, ^{b} and ^{c} respectively denote significance at the 1%, 5% and 10% levels.

7 Conclusion

This paper investigates the export-enhancing effect of foreign employment at the firm level. Theoretically, we rationalize the effect of foreign workers on their firm's exports at both the intensive and the extensive margins. Using a model of heterogeneous firms in monopolistic competition, we highlight that foreign workers allow their firm to be more productive, and convey valuable information to their employer on foreign markets, particularly on their origin country. The model predicts that the probability to export and the exported quantity should positively react to the employment of foreign workers.

With a French firm-level dataset over the 1997-2008 period, we use a propensity score matching method to evaluate the effect of foreign employment on export outcomes. We find a positive effect of foreign-born workers on the export value and volume, the probability of exporting, the number of destinations served and the number of exported products. In line with the literature, we find that the export-enhancing effect of foreign workers is stronger for skilled individuals but not nil for unskilled workers. We also find evidence that employing foreign workers favors exports toward all destinations. This result is a contribution to the existing literature that extensively focuses on the destination-specific informational channel.

These results are quite instructive on the link between foreign employment and export outcomes, particularly at the intensive margin. Future research could try to further investigate the mechanisms through which foreign workers enhance productivity. One research avenue could be to further look at the supply side of the labor market, looking at how foreign and native workers differ in terms of skills and experience, but also regarding the types of contracts they accept. It would help us to fully understand the relation of causality between foreign employment, productivity and export outcomes.

Finally, our results suggest that skilled and unskilled foreign employment are either harmless or positive for export outcomes. In that respect, a simplification of labor regulations for foreign workers could create further incentives for French firms to hire these workers. This could, in turn, create favorable conditions within the employing firm to start exporting or to expand its export activities.

In the current context, policy makers should bear in mind that a tightening of immigration policies and labor regulations for immigrants may impact firms' export outcomes. At the extensive margin, firms may experience a loss of opportunities to start exporting. At the intensive margin, one could expect a nil or negative impact on exports. If these restrictions target immigrants from a particular origin country, the effect may be unevenly spread across export destinations, and could even lead to the redistribution of existing export flows toward a more restrictive set of destinations.

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References

Austin, P. C., "Balance diagnostics for comparing the distribution of baseline covariates between treatment groups in propensity-score matched samples," *Statistics in Medicine*, 11 2009, *28* (25), 3083–3107.

Bernard, A. B., J. B. Jensen, S. J. Redding, and P. K. Schott, "The Empirics of Firm Heterogeneity and International Trade," *Annual Review of Economics*, 2012, *4* (1), 283–313.

Bombardini, M., G. Orefice, and M. D. Tito, "Does Exporting Improve Matching? Evidence from French Employer-Employee Data," NBER Working Papers 21225, National Bureau of Economic Research 2015.

Borjas, G. J., "The Labor Demand Curve is Downward Sloping: Reexamining the Impact of Immigration on the Labor Market," *The Quarterly Journal of Economics*, 2003, *118* (4), 1335–1374.

Brücker, H., S. Capuano, and A. Marfouk, "Education, gender and international migration: insights from a panel-dataset 1980-2010," *mimeo*, 2013.

Card, D., "Immigrant Inflows, Native Outflows, and the Local Labor Market Impacts of Higher Immigration," *Journal of Labor Economics*, 2001, *19* (1), 22–64.

Chaney, T., "Distorted gravity: the intensive and extensive margins of international trade," *The American Economic Review*, 2008, *98* (4), 1707–1721.

Choquette, E. and P. Meinen, "Export Spillovers: Opening the Black Box," *The World Economy*, 2015, *38* (12), 1912–1946.

Disdier, A.-C. and K. Head, "The Puzzling Persistence of the Distance Effect on Bilateral Trade," *Review of Economics and Statistics*, 2008, *90* (1), 37–48.

Felbermayr, G. J. and F. Toubal, "Revisiting the Trade-Migration Nexus: Evidence from New OECD Data," *World Development*, 2012, *40* (5), 928–937.

Goldin, I., G. Cameron, and M. Balarajan, *Exceptional people: How migration shaped our world and will define our future.*, Princeton University Press, 2011.

Goodall, K. and J. Roberts, "Only connect: teamwork in the multinational," *Journal of World Business*, 2003, *38* (2), 150 – 164.

Gould, D. M., "Immigrant links to the home country: empirical implications for US bilateral trade flows," *The Review of Economics and Statistics*, 1994, pp. 302–316.

Hatzigeorgiou, A. and M. Lodefalk, "Trade, Migration and Integration - Evidence and Policy Implications," *The World Economy*, 2014.

__ **and** __ , "Migrants' Influence on Firm-level Exports," *Journal of Industry, Competition and Trade*, 2016, *16* (4), 477–497.

Hiller, S., "Does Immigrant Employment Matter for Export Sales? Evidence from Denmark," *Review of World Economics*, 2013, *149* (2), 369–394.

Loth, D., "Le fonctionnement des équipes interculturelles," *Management & Avenir*, 2009, (8), 326–344.

Melitz, M. J., "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, 2003, *71* (6), 1695–1725.

Minondo, A., "Learning to Export with New Managers," *Empirical Economics Letters*, 2011, *10* (1), 7–11.

Mitaritonna, C., G. Orefice, and G. Peri, "Immigrants and Firms' Outcomes: Evidence from France," Working Paper 22852, NBER 2016.

Mrázová, M. and J. P. Neary, "Selection effects with heterogenous firms," Discussion Paper DP9288, Centre for Economic Policy Research January 2013.

Parrotta, P., D. Pozzoli, and D. Sala, "Ethnic diversity and firms' export behavior," *European Economic Review*, 2016, *89*, 248–263.

__ **,** __ **, and M. Pytlikova**, "Labor diversity and firm productivity," *European Economic Review*, 2014, *66*, 144 – 179.

Parsons, C. R. and L. A. Winters, "International Migration, Trade and Aid: A Survey," in R. E. B. Lucas, ed., *International Handbook on Migration and Economic Development*, Elgar original reference, 2014, chapter 4, pp. 65–112.

Peri, G. and C. Sparber, "Task Specialization, Immigration, and Wages," *American Economic Journal: Applied Economics*, 2009, *1* (3), 135–169.

__ **and F. Requena-Silvente**, "The trade creation effect of immigrants: evidence from the remarkable case of Spain," *Canadian Journal of Economics*, 2010, *43* (4), 1433–1459.

Rauch, J. E., "Business and social networks in international trade," *Journal of Economic Literature*, December 2001, *XXXIX*, 1177–1203.

Rosenbaum, P. R. and D. B. Rubin, "The central role of the propensity score in observational studies for causal effects," *Biometrika*, 1983, *70* (1), 41–55.

Trax, M., S. Brunow, and J. Suedekum, "Cultural diversity and plant-level productivity," *Regional Science and Urban Economics*, 2015, *53*, 85–96.

Appendix

Table 9: Propensity score estimations

Dependent variable: $D_{it} = 1$ if $M_{it} > 0$	(1)	(2)
Mean Age of Workers	-0.003	-0.117^a
	(0.003)	(0.014)
Nr. of CS1	0.086^a	0.925^a
	(0.003)	(0.013)
Nr. of CS2	0.140^a	0.775^a
	(0.003)	(0.010)
Herf. CS1	0.149^a	1.380^a
	(0.005)	(0.014)
Herf. CS2	0.007^a	-0.039^a
	(0.002)	(0.011)
Nr. of skilled workers	0.050^a	0.224^a
	(0.001)	(0.003)
Firm Age	-0.001	-0.046^a
	(0.001)	(0.004)
Employment	0.013^a	0.147^a
	(0.002)	(0.004)
Assets	0.007^a	-0.069^a
	(0.002)	(0.003)
Own resources	0.500	3.717^a
	(0.611)	(1.076)
Firm FE	yes	no
Sector FE	yes	no
Region FE	yes	no
Year FE	yes	no
Obs.	3,913,479	3 047 028
Estimator	OLS	Logit
R^2	0.559	0.209

Note: This table provides the first-step estimation results allowing us to compute the scores (equation 17). The dependent variable denoted D_{it} equals 1 if $M_{it} > 0$ and 0 otherwise. M_{it} denotes the share of foreign workers in firm i at time t. All independent variables are in logarithm and lagged $(t-1)$. In column (1), we use an OLS estimator and include a set of fixed effects. In column (2), we use a logit estimator. Robust standard errors are shown in parentheses. a, b and c respectively denote significance at the 1%, 5% and 10% levels.

Table 10: Average Treatment Effect estimates - Matching per import growth quartiles

Treatment (D_{it})	(1) $M_{it} > 0$	(2) $M_{it} > M_{it-1}$	(3) $M_{it} > M_{it-1}$ $M_{it-1} > 0$	(4) $M^S_{it} > 0$	(5) $M^S_{it} > M^S_{it-1}$	(6) $M^S_{it} > M^S_{it-1}$ $M^S_{it-1} > 0$	(7) $M^U_{it} > 0$	(8) $M^U_{it} > M^U_{it-1}$	(9) $M^U_{it} > M^U_{it-1}$ $M^U_{it-1} > 0$
Propensity score estimator	OLS								
Matching algorithm	Closest neighbor								
Matching constraint	Import growth quartiles								
	Intensive Margin								
Export Value	0.277^a	0.242^a	0.209^a	0.363^a	0.297^a	0.310^a	0.169^a	0.253^a	0.223^a
	(0.030)	(0.032)	(0.051)	(0.038)	(0.046)	(0.111)	(0.032)	(0.036)	(0.055)
Export Quantity	0.260^a	0.179^a	0.157^a	0.312^a	0.251^a	0.153^a	0.169^a	0.216^a	0.191^a
	(0.038)	(0.041)	(0.062)	(0.049)	(0.058)	(0.135)	(0.041)	(0.044)	(0.067)
	Extensive Margin								
Nr. of Destinations	0.103^a	0.104^a	0.074^a	0.127^a	0.092^a	0.054	0.074^a	0.118^a	0.084^a
	(0.013)	(0.014)	(0.022)	(0.017)	(0.021)	(0.047)	(0.014)	(0.015)	(0.024)
Nr. of Products	0.134^a	0.137^a	0.100^a	0.174^a	0.125^a	0.074	0.094^a	0.161^a	0.105^a
	(0.017)	(0.019)	(0.029)	(0.022)	(0.027)	(0.064)	(0.019)	(0.021)	(0.032)
Participation Dummy	0.032^a	0.036^a	0.022^a	0.019^a	0.014^a	0.003	0.029^a	0.030^a	0.017^b
	(0.004)	(0.004)	(0.007)	(0.005)	(0.006)	(0.013)	(0.004)	(0.005)	(0.008)

Note: This table provides the ATT estimates for the five dependent variables. All trade margins measures are in logarithm, except the participation dummy. Propensity scores upon which the matching is made are computed using predictions from the estimation of equation (17). M_{it}, M^S_{it} and M^U_{it} respectively denote the share of foreign, skilled foreign and unskilled foreign workers in firm i at time t. We match firms using the estimated propensity scores from the same region-sector and that belong to the same import growth quartile. Robust standard errors are shown in parentheses. ^{a}, ^{b} and ^{c} respectively denote significance at the 1%, 5% and 10% levels.

Table 11: Matching quality - robustness

Treatment	$M_{it} > 0$											
Propensity Score Estimator	OLS			OLS			OLS			Logit		
Matching Algorithm	Closest neighbor			Closest neighbor			5 closest neighbors			Closest neighbors		
Additional constraint	Import growth quartile			Export growth quartile			-			-		
	Treated	Control	% bias	Treated	Control	% bias	Treated	Control	% bias	Treated	Control	% bias
Mean Age of Workers	3.61	3.61	0.02	3.61	3.62	-0.04	3.61	3.61	-0.02	3.61	3.62	-0.02
Nr. of CS1	1.07	1.04	0.08	1.07	0.93	0.35	1.07	0.93	0.29	1.07	0.91	0.35
Nr. of CS2	1.89	1.81	0.11	1.89	1.55	0.45	1.89	1.59	0.38	1.89	1.54	0.44
Herf. CS1	-0.53	-0.52	-0.04	-0.53	-0.049	-0.10	-0.53	-0.51	-0.07	-0.53	-0.48	-0.13
Herf. CS2	-1.33	-1.27	-0.08	-1.33	-1.17	-0.29	-1.33	-1.19	-0.23	-1.33	-1.17	-0.28
Nr. of skilled workers	1.92	1.83	0.14	1.92	1.42	0.44	1.88	1.44	0.39	1.88	1.36	0.47
Firm Age	2.87	2.85	0.01	2.87	2.84	0.03	2.86	2.84	0.04	2.86	2.82	0.05
Employment	3.78	3.76	0.01	3.68	3.47	0.15	3.62	3.43	0.13	3.62	3.38	0.18
Assets	8.86	8.82	0.03	8.71	8.53	0.11	8.62	8.44	0.11	8.62	8.41	0.16
Own Resources	0.09	0.09	0.01	0.09	0.09	0.01	0.09	0.09	0.01	0.09	0.09	0.01

Note: This table provides the observed means of firm characteristics (C_{it}) for the treated and the control groups after score matching and computation of the ATT on the export value. All variables are in logarithm and lagged ($t-1$). M_{it} denotes the share of foreign workers in firm i at time t. We compare the two means using a relative bias measures, relating the quality of the matching procedure. *% bias* denotes the normalized relative bias between the two means; see Austin (2009).

Table 12: Average Treatment Effect estimates - Matching per export growth quartiles

Treatment (D_{it})	(1) $M_{it} > 0$	(2) $M_{it} > M_{it-1}$	(3) $M_{it} > M_{it-1}$ $M_{it-1} > 0$	(4) $M^S_{it} > 0$	(5) $M^S_{it} > M^S_{it-1}$	(6) $M^S_{it} > M^S_{it-1}$ $M^S_{it-1} > 0$	(7) $M^U_{it} > 0$	(8) $M^U_{it} > M^U_{it-1}$	(9) $M^U_{it} > M^U_{it-1}$ $M^U_{it-1} > 0$
Propensity score estimator	OLS								
Matching algorithm	Closest neighbor								
Matching constraint	Export growth quartiles								
	Intensive Margin								
Export Value	0.251^a	0.233^a	0.162^a	0.433^a	0.331^a	0.317^a	0.202^a	0.229^a	0.124^a
	(0.026)	(0.028)	(0.043)	(0.031)	(0.041)	(0.099)	(0.027)	(0.031)	(0.047)
Export Quantity	0.335^a	0.252^a	0.171^a	0.398^a	0.331^a	0.199	0.318^a	0.273^a	0.199^a
	(0.033)	(0.036)	(0.054)	(0.041)	(0.053)	(0.123)	(0.036)	(0.039)	(0.059)
	Extensive Margin								
Nr. of Destinations	0.059^a	0.079^a	0.023	0.123^a	0.102^a	0.069	0.046^a	0.071^a	0.016
	(0.011)	(0.012)	(0.019)	(0.014)	(0.018)	(0.043)	(0.012)	(0.014)	(0.021)
Nr. of Products	0.100^a	0.121^a	0.056^b	0.186^a	0.162^a	0.103	0.077^a	0.118^a	0.045
	(0.016)	(0.017)	(0.026)	(0.019)	(0.024)	(0.059)	(0.016)	(0.018)	(0.028)

Note: This table provides the ATT estimates for the five dependent variables. All trade margins measures are in logarithm, except the participation dummy. Propensity scores upon which the matching is made are computed using predictions from the estimation of equation (17). M_{it}, M^S_{it} and M^U_{it} respectively denote the share of foreign, skilled foreign and unskilled foreign workers in firm i at time t. We match firms using the estimated propensity scores from the same region-sector and that belong to the same quartile of pre-treatment export growth. Robust standard errors are shown in parentheses. ^{a}, ^{b} and ^{c} respectively denote significance at the 1%, 5% and 10% levels.

Table 13: Average Treatment Effect estimates - 5 neighbours matching algorithm

Treatment (D_{it})	(1) $M_{it} > 0$	(2) $M_{it} > M_{it-1}$	(3) $M_{it} > M_{it-1}$ $M_{it-1} > 0$	(4) $M^S_{it} > 0$	(5) $M^S_{it} > M^S_{it-1}$	(6) $M^S_{it} > M^S_{it-1}$ $M^S_{it-1} > 0$	(7) $M^U_{it} > 0$	(8) $M^U_{it} > M^U_{it-1}$	(9) $M^U_{it} > M^U_{it-1}$ $M^U_{it-1} > 0$
Propensity score estimator	OLS								
Matching algorithm	5 closest neighbors								
Matching constraint	Same region-sector								
	Intensive Margin								
Export Value	0.252^a	0.268^a	0.167^a	0.454^a	0.394^a	0.357^a	0.200^a	0.242^a	0.142^a
	(0.020)	(0.022)	(0.034)	(0.025)	(0.032)	(0.077)	(0.022)	(0.032)	(0.037)
Export Quantity	0.320^a	0.284^a	0.178^a	0.428^a	0.381^a	0.211^b	0.301^a	0.283^a	0.201^a
	(0.026)	(0.027)	(0.041)	(0.032)	(0.040)	(0.096)	(0.028)	(0.029)	(0.044)
	Extensive Margin								
Nr. of Destinations	0.067^a	0.094^a	0.034^b	0.145^a	0.126^a	0.076^b	0.049^a	0.085^a	0.022
	(0.008)	(0.009)	(0.014)	(0.011)	(0.014)	(0.032)	(0.009)	(0.010)	(0.015)
Nr. of Products	0.103^a	0.141^a	0.054^a	0.206^a	0.186^a	0.116^a	0.079^a	0.131^a	0.044^b
	(0.012)	(0.012)	(0.019)	(0.014)	(0.018)	(0.044)	(0.012)	(0.014)	(0.021)
Participation Dummy	0.017^a	0.018^a	0.008^a	0.021^a	0.019^a	0.013^b	0.017^a	0.019^a	0.011^a
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.006)	(0.001)	(0.001)	(0.003)

Note: This table provides the ATT estimates for the five dependent variables. All trade margins measures are in logarithm, except the participation dummy. Propensity scores upon which the matching is made are computed using predictions from the estimation of equation (17). M_{it}, M^S_{it} and M^U_{it} respectively denote the share of foreign, skilled foreign and unskilled foreign workers in firm i at time t. We match firms using the estimated propensity scores from the same region-sector. We use a 5-neighbor matching procedure. Robust standard errors are shown in parentheses. ^{a}, ^{b} and ^{c} respectively denote significance at the 1%, 5% and 10% levels.

Table 14: Average Treatment Effect estimates - Logit estimation for scores

Treatment (D_{it})	(1) $M_{it} > 0$	(2) $M_{it} > M_{it-1}$	(3) $M_{it} > M_{it-1}$ $M_{it-1} > 0$	(4) $M^S_{it} > 0$	(5) $M^S_{it} > M^S_{it-1}$	(6) $M^S_{it} > M^S_{it-1}$ $M^S_{it-1} > 0$	(7) $M^U_{it} > 0$	(8) $M^U_{it} > M^U_{it-1}$	(9) $M^U_{it} > M^U_{it-1}$ $M^U_{it-1} > 0$
Propensity score estimator	Logit								
Matching algorithm	Closest neighbor								
Matching constraint	Same region-sector								
	Intensive Margin								
Export Value	0.410^a	0.220^a	0.223^a	0.412^a	0.285^a	0.251^b	0.411^a	0.245^a	0.210^a
	(0.027)	(0.027)	(0.042)	(0.034)	(0.039)	(0.101)	(0.028)	(0.029)	(0.046)
Export Quantity	0.458^a	0.236^a	0.245^a	0.424^a	0.287^a	0.108	0.485^a	0.292^a	0.252^a
	(0.034)	(0.034)	(0.052)	(0.042)	(0.050)	(0.123)	(0.035)	(0.037)	(0.055)
	Extensive Margin								
Nr. of Destinations	0.130^a	0.072^a	0.066^a	0.139^a	0.090^a	0.032	0.130^a	0.085^a	0.057^a
	(0.011)	(0.011)	(0.018)	(0.014)	(0.016)	(0.042)	(0.011)	(0.012)	(0.019)
Nr. of Products	0.188^a	0.111^a	0.090^a	0.188^a	0.143^a	0.082	0.187^a	0.120^a	0.076^a
	(0.015)	(0.016)	(0.024)	(0.019)	(0.022)	(0.056)	(0.016)	(0.017)	(0.026)
Participation Dummy	0.024^a	0.014^a	0.012^a	0.018^a	0.013^a	0.012	0.026^a	0.017^a	0.015^a
	(0.001)	(0.002)	(0.003)	(0.002)	(0.002)	(0.007)	(0.002)	(0.002)	(0.003)

Note: This table provides the ATT estimates for the five dependent variables. All trade margins measures are in logarithm, except the participation dummy. Propensity scores upon which the matching is made are computed using predictions from the estimation of equation (17) using a logit estimator. M_{it}, M^S_{it} and M^U_{it} respectively denote the share of foreign, skilled foreign and unskilled foreign workers in firm i at time t. We match firms using the estimated propensity scores from the same region-sector. Robust standard errors are shown in parentheses. ^{a}, ^{b} and ^{c} respectively denote significance at the 1%, 5% and 10% levels.