Absorption of Foreign Knowledge: Firms' Benefits of Employing Immigrants *

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Abstract

This paper uses Danish matched employer-employee data from manufacturing firms covering the period 2000 to 2011 to examine the impact of foreign knowledge possessed by the firms' immigrant workers on firm-level total factor productivity (TFP). We construct various measures of firm-specific foreign R&D knowledge variables that link firms' immigrant workers to their corresponding country of origin R&D knowledge stocks. The empirical results suggest that firms employing immigrant workers from technologically advanced countries benefit from higher firm-level TFP. This result is in accordance with the notion that immigrant workers facilitate firms' absorptive capacity through increased awareness of international R&D knowledge stocks. Additional results reveal that the estimated impact on firm-level TFP is larger for firms employing immigrant workers with the highest educational status and immigrant workers performing high-skilled occupational tasks.

Keywords: R&D Knowledge Spillovers, Absorptive Capacity, Firm-Level Analysis, Foreign Experts, Immigrant Workers

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1 Introduction

Immigrant employees have a substantial impact on the economic performance of the firms that employ them. Their diverse cultural backgrounds may be both, a boon and a bane: Firms may incur high coordination costs from having an ethnically diverse labor force, but they may also benefit significantly from the knowledge and social capital provided by immigrant workers. Recent empirical findings have highlighted the substantial costs of ethnic diversity. According to Parrotta et al. (2014b), although ethnic diversity may spur innovation, it is detrimental to firm-level productivity (Parrotta et al., 2014a). Yet as additional research has shown, immigrant employees have the capacity to lower informational barriers and open up trading opportunities by exploiting ties to their ethnic networks (Rauch, 2001; Rauch and Trindade, 2002; Peri and Requena-Silvente, 2010) and helping to boost firm trade with their home countries (Bastos and Silva, 2012; Hiller, 2013; Hatzigeorgiou and Lodefalk, 2015). Furthermore, immigrants may not only help to lower barriers to trade in the firms where they work but also increase international knowledge acquisition by extending the firm's absorptive capacity (Cohen and Levinthal, 1990).

According to Cohen and Levinthal (1994, p. 227), the successful absorption of foreign knowledge makes it necessary to "evaluate the technological and commercial potential of knowledge in a particular domain, assimilate it, and apply it". Specifically, Arrow (1969) points out that the transfer of knowledge requires that the foreign knowledge first has to be decoded by the recipient. This decoding process requires not only prior technological knowledge but also linguistic and cultural knowledge as well as personal contacts.[1] Thus immigrant employees equipped with a particular language, a certain cultural background, or personal contacts can increase a firm's ability to absorb knowledge from the external environment.

The arguments put forward in Arrow (1969) are supported by an empirical study by Kerr (2008), who argues that international ethnic scientific networks foster the diffusion of knowledge among nations around the world. The author shows that foreign researchers outside the US cite researchers of their own ethnicity within the US more frequently than researchers from other ethnic groups, thus contributing significantly to technology diffusion between developed and emerging countries. The underlying argument is that ethnic scientific networks increase awareness of recent technological developments and foster trust in otherwise uncertain legal environments. The importance of social capital in co-ethnic networks that facilitate knowledge exchange between innovators through enhanced trustworthiness has been analyzed by Coleman (1988) and Kalnins and Chung (2006). The function of reputation intermediaries in industries where tacit knowledge is important has been shown by Kapur (2001). With regard to the sources of technology transfers, Agrawal et al. (2008) have shown that social proximity (e.g., co-ethnic networks) among members of the US resident Indian diaspora substitutes for geographical proximity in its role for knowledge diffusion. Their result is particularly relevant for firms recruiting immigrant workers to increase their innovation

[1] Arrow cites the development of jet engines during the Second World War as an example: When British authorities decided to share plans for the jet engine with US allies, it took US researchers as long as ten months to redraw the plans to make them suitable for American usage.

capacities through their access to foreign knowledge flows: Hiring immigrants may – to some extent – overcome the need for "incurring the cost of moving teacher and student into the same geographical location" (Keller, 2004, p. 756) to pass on tacit knowledge. That firms' hiring decisions in general matter for inter-firm knowledge transmission has been shown by Balsvik (2011), Parrotta and Pozolli (2012), and Poole (2013).

Thus, the considerations raised by Arrow (1969) and the aforementioned empirical evidence on co-ethnic networks suggest that immigrant employees might extend a firm's absorptive capacity and facilitate the absorption of international knowledge spillovers. However, this aspect of immigrant employment has not been analyzed in depth in the firm-level productivity literature. To the best knowledge of the authors, there are only three studies – Markusen and Trofimenko (2009), Malchow-Møller et al. (2011), and Mitaritonna et al. (2014) – that provide empirical evidence for the importance of immigrant workers for firm-level productivity (approximated by individual wage outcomes). The study by Markusen and Trofimenko (2009) shows that in Colombian manufacturing plants, hiring foreign experts increases wages of the domestic workers with some time lag. Malchow-Møller et al. (2011) found that employment of foreign high-skilled workers raises productivity in a panel of Danish firms. In a more recent paper, Mitaritonna et al. (2014) report empirical evidence for a positive effect of immigrants employed in French firms on total factor productivity (TFP). However, as these studies do not control for the knowledge in the home countries of the hired immigrant workers, they cannot distinguish between the influence of the personal skills of the employed immigrants and the influence of the knowledge the immigrants absorbed abroad and passed on. However, this differentiation is crucial in identifying how immigrant workers affect firm-level productivity by extending the firm's absorptive capacity.

In this paper, we examine the impact of immigrant workers on firm-level TFP through knowledge spillovers. To this end, we use Danish linked employer-employee data from Statistics Denmark covering the period 2000 to 2011. The empirical analysis is performed in two steps. In the first step, we calculate firm-level TFP for manufacturing industries using the Wooldridge (2009) Generalized Methods of Moments (GMM) estimation procedure from the Levinsohn and Petrin (2003) structural production function approach using intermediate inputs to control for unobserved firm-specific productivity shocks. In step two, firm-level TFP is regressed on various foreign R&D knowledge variables measuring the extent of foreign knowledge inherent in a firm's immigrant workers. These measures set the immigrant workers employed in a firm in relation to their country of origin's R&D knowledge stocks. Our contribution to the recent literature on firm performance is to assess for the first time how immigrants allow firms to access international knowledge capital. Our rich employer-employee panel allows us to control for endogeneity concern arising due to unobserved heterogeneity and for other crucial confounding factors.

The empirical results suggest that firms employing immigrant workers from technologically advanced countries have higher firm-level TFP outcomes. This result is in accordance with the main hypothesis put forward in this paper that immigrant workers facilitate firms' absorptive capacity by increasing access to international R&D knowledge stocks, a finding that is robust to a wide range of firm-specific controls such as firm fixed effects, industry-year fixed effects, region fixed effects, firm age, education, and occupation controls. We show that especially immigrant workers with the highest educational status and immigrant workers employed in skill-intense occupational positions transmit foreign knowledge effectively, therefore contributing significantly to overall firm-level TFP. We perform a series of additional robustness tests to check the sensitivity of the main empirical findings. Specifically, the results are robust to (i) trade-related knowledge spillovers, (ii) the exclusion of multinational enterprises and high-technology firms, which may be particularly successful of absorbing international knowledge effectively, and (iii) different production estimators used in the calculation of firm-level TFP. Additionally, we confirm existing findings that firm-level workforce ethnic diversity is associated with a negative TFP elasticity (Parrotta et al., 2014a). However, in contrast to this "bane" of immigrant employment, the findings presented in the current paper provide positive evidence of a "boon" of immigrant employment. That is, an ethnically diverse workforce is an important determinant of a firm's capacity to absorb international knowledge, thus contributing significantly to firm-level TFP.

The remaining parts of the paper are organized as follows. In Section 2, we outline the empirical approach, which constitutes the basis for the subsequent empirical analysis. Section 3 describes the data and methods behind the construction of various firm-specific foreign R&D knowledge variables measuring the extent of foreign knowledge in firms' immigrant workers. Section 4 presents the empirical results, and Section 5 checks the robustness of the results to various sample sizes, model specifications, and production function estimators. Finally, Section 6 concludes by summarizing the main results.

2 Estimation Methodology

In this section, we outline the empirical strategy for estimating the impact of foreign R&D knowledge inherent in firms' immigrant workers on firm-level TFP. We follow the standard procedure in the firm-level literature. This involves two separate steps: in the first step, productivity is derived from a Cobb-Douglas production function using one of the available structural production function estimators (Olley and Pakes, 1996; Levinsohn and Petrin, 2003; Ackerberg et al., 2006; Wooldridge, 2009).[2] The productivity measure obtained from the previous step can then be used to evaluate the association between firm-level TFP and various foreign R&D knowledge variables capturing the international knowledge possessed by firms' immigrant employees, conditional on a vector of firm-specific controls.

2.1 Firm-Level Production Function Estimates

In this paper, in the first step TFP is estimated by the Wooldridge (2009) method based on the Levinsohn and Petrin (2003) approach using intermediate inputs as the proxy variable to control for unobserved firm-specific productivity

[2] For a critical discussion on firm-level structural production function estimators, the interested reader is referred to Eberhardt and Helmers (2010).

shocks. Specifically, we rely on a Cobb-Douglas production function having the form:

$$y_{ijt} = \beta_0 + \beta_l l_{ijt} + \beta_k k_{ijt} + \beta_m m_{ijt} + \varepsilon_{ijt}, \tag{1}$$

where y_{ijt} is the log of gross production, l_{ijt} is the log of labor, k_{ijt} is the log of capital, and m_{ijt} is the log of materials utilized in firm i at year t in industry j, respectively. The error term, ε_{ijt}, is assumed to have the form:

$$\varepsilon_{ijt} = \omega_{ijt} + \eta_{ijt}, \tag{2}$$

where ω_{ijt} is the transmitted productivity component and η_{ijt} is a purely random (unexpected) productivity shock. The difficulty in estimating equation (1) directly concerns the possible endogeneity problem between the firm's decision on their choice of inputs (l, k, m) given the contemporaneous firm-specific productivity shock, which is observed by the firm but *not* by the econometrician. To tackle this "transmission bias" on the traditional input coefficients, a wide variety of structural production function estimators have been developed (Olley and Pakes, 1996; Levinsohn and Petrin, 2003; Ackerberg et al., 2006; Wooldridge, 2009). The solution to the transmission bias problem is to use information on observed investment inv_{ijt} (Olley and Pakes, 1996) or materials m_{ijt} (Levinsohn and Petrin, 2003) to proxy for unobserved firm-specific productivity shocks ω_{ijt}. Following the semi-parametric estimation approach in Levinsohn and Petrin (2003), a key implication of the theory is that materials are strictly increasing in both capital and productivity. Therefore, it follows for some general function $m(\cdot)$:

$$m_{ijt} = m(k_{ijt}, \omega_{ijt}). \tag{3}$$

The assumption set in equation (3) is that firms with higher capital stocks (k_{ijt}) or productivity shocks (ω_{ijt}) have a higher demand for material inputs. Provided that materials are strictly positive, it is possible to express the inverse function for the unobservable productivity shock (ω_{ijt}) as follows:

$$\omega_{ijt} = m^{-1}(k_{ijt}, m_{ijt}) \equiv g(k_{ijt}, m_{ijt}). \tag{4}$$

Equation (4) now expresses the *unobservable* productivity shock as a function of *observable* state and proxy variables, which can be controlled for in the production function.

Finally, Levinsohn and Petrin (2003) use an assumption about the evolution in the productivity process to identify the coefficient estimate for capital (β_k) in the second stage of their semi-parametric estimation approach. Specifically, the authors assume that productivity evolves according to a first-order Markov process, meaning that firm's expectations about its productivity level depends solely on the last period's expectation:

$$\mathbb{E}[\omega_{ijt}|\omega_{ij,t-1}, ..., \omega_{ij1}] = \mathbb{E}[\omega_{ijt}|\omega_{ij,t-1}], \tag{5}$$

along with the additional assumption that the forecast error

$$\xi_{ijt} = \omega_{ijt} - \mathbb{E}[\omega_{ijt}|\omega_{ij,t-1}] \tag{6}$$

is uncorrelated with capital k_{ijt}. The identification of β_k is achieved based on a timing assumption regarding the evolution of k_{ijt} that was determined by the firm's last-period investment decisions. Wooldridge (2009) strengthens this assumption, imposing that lagged state and proxy variables $(k_{ij,t-1}, m_{ij,t-1})$ are uncorrelated with the forecast error ξ_{ijt} to identify the production function coefficients:

$$\mathbb{E}[\omega_{ijt}|k_{ij,t}, l_{ij,t-1}, k_{ij,t-1}, m_{ij,t-1}, ..., l_{ij1}, k_{ij1}, m_{ij1}] \\ = \mathbb{E}[\omega_{ijt}|\omega_{ij,t-1}] \equiv f\left[g(k_{ij,t-1}, m_{ij,t-1})\right]. \tag{7}$$

Equation (7) allows current values of the variable inputs (labor l_{ijt} and materials m_{ijt} in this case) to be correlated with ξ_{ijt}, but k_{ijt} and past values of $(l_{ijt}, k_{ijt}, m_{ijt})$ to be uncorrelated with ξ_{ijt}. Inserting $\omega_{ijt} = f\left[g(k_{ij,t-1}, m_{ij,t-1})\right] + \xi_{ijt}$ into the production function yields the following specification, which corresponds to equation (2.11) in Wooldridge (2009):

$$y_{ijt} = \beta_0 + \beta_l l_{ijt} + \beta_k k_{ijt} + \beta_m m_{ijt} + f\left[g(k_{ij,t-1}, m_{ij,t-1})\right] + u_{ijt}, \tag{8}$$

where $u_{ijt} \equiv \xi_{ijt} + \varepsilon_{ijt}$. The orthogonality conditions to identify the production function parameters are expressed as:

$$\mathbb{E}[u_{ijt}|k_{ij,t}, l_{ij,t-1}, k_{ij,t-1}, m_{ij,t-1}, ..., l_{ij1}, k_{ij1}, m_{ij1}] = 0. \tag{9}$$

We approximate $f\left[g(k_{ij,t-1}, m_{ij,t-1})\right]$ using a third-order polynomial expansion in the variables $(k_{ij,t-1}, m_{ij,t-1})$. In addition to the contemporaneous state variable (k_{ijt}), we use first- and second-order lags of labor (l_{ijt}) and second-order lags of materials (m_{ijt}) as additional instrumental variables (IVs) to identify the production function parameters of the endogenous variables for labor (β_l) and materials (β_m), respectively.

The estimation approach proposed by Wooldridge (2009) offers a number of advantages compared to the standard semi-parametric approach of Levinsohn and Petrin (2003). First, standard errors of the production function parameters can be obtained relying on the standard GMM estimation framework. In contrast, because of the two-step estimation procedure, the semi-parametric approach requires bootstrapping methods to obtain standard errors for the input factors. Second, the *one-step* GMM estimator is more efficient than the *two-step* semi-parametric approach, because the latter procedure ignores the potential correlation across the two equations. Furthermore, specifying an optimal weighting matrix, the GMM framework is able to effectively account for firm-level serial correlation and heteroscedasticity. Third, under the Wooldridge (2009) estimation approach, there exist generally more IVs than endogenous variables, which allows for a possible overidentification restrictions test (e.g, testing the joint validity of the instrumental variables).

Although we choose the Wooldridge (2009) estimator for our main analysis, TFP estimates based alternative estimators are required for the robustness analysis carried out later on. The production function estimates for manufacturing firms are reported in Table 9. The results shown in column (1) refer to the Wooldridge (2009) GMM estimation method of the Levinsohn and Petrin (2003) approach (henceforth referred as the WLP estimator) using materials as the proxy to control for unobserved firm-specific productivity shocks. This is the TFP estimation used in the following analysis.

In the remaining columns, we report the estimated elasticities for the traditional inputs labor, materials, and capital using alternative production function estimates which are required in the robustness analysis. In column (2), we again use the Wooldridge (2009) GMM estimation method but this time with investment, as in Olley and Pakes (1996), as the proxy to control for unobserved firm-specific productivity shocks (henceforth referred as the WOP estimator). In this case, the firm-specific productivity shock is approximated using a third-order polynomial expansion in the variables $(k_{ij,t-1}, inv_{ij,t-1})$, where inv refers to the log of investment. Column (3) reports production function results of the conventional Levinsohn and Petrin (2003) semi-parametric estimation approach (henceforth referred as the LP estimator). In column (4), we report results from the Cobb-Douglas production function estimated by OLS with firm fixed effects. Since production function estimators including firm fixed effects rule out possibilities of time-varying productivity shocks, the estimator in column (5) includes firm fixed effects that vary across four time periods. As discussed in Petrin and Sivadasan (2013), this estimator remains consistent if the transmitted productivity shock behaves like $\omega_{ijt} = \omega_{ijp}$, where p refers to one of the four time periods (2000-2002, 2003-2005, 2006-2008, 2009-2011). Finally, to ensure a more flexible production function specification concerning the output and substitution elasticities with respect to the traditional input factors labor, materials, and capital, we estimate the following second-order translog production function:

$$y_{ijt} = \beta_0 + \sum_{\psi} \beta_\psi \psi_{ijt} + \sum_{\psi} \beta_{\psi\psi} \psi_{ijt}^2 + \sum_{\psi \neq \tau} \sum_{\tau} \beta_{\psi\tau} \psi_{ijt} \tau_{ijt} + \omega_{ijp} + \varepsilon_{ijt}, \tag{10}$$

where $\psi, \tau = \{l, k, m\}$. We estimate the translog production function by OLS including firm fixed effects that vary across the four time periods, as mentioned earlier. The corresponding results are shown in column (6). Overall, the estimated input elasticities are similar when using either the WLP or WOP approach. The estimated elasticity for materials of the LP approach is much smaller compared to the WLP and WOP approach, whereas for capital, the estimated elasticity is larger. For labor, the estimated elasticity is similar in the WLP, WOP, and LP estimation approach. As expected, estimated input elasticities from the Cobb-Douglas production function estimated by OLS with firm fixed effects differ substantially from structural production function estimators such as WLP, WOP, and LP. We leave out the comparison of the estimated input elasticities in the Translog case, as these are allowed to be flexible. In the robustness section, we check the sensitivity of our main results to these alternative production function estimators.

2.2 Estimating the Impact of Foreign R&D Knowledge on Firm-Level TFP

Using the coefficient estimates of the production function parameters outlined in the previous section, the log of TFP for firm i in industry j at time t is constructed as follows:

$$\ln\left(\widehat{TFP}_{ijt}\right) = y_{ijt} - \hat{\beta}_l l_{ijt} - \hat{\beta}_k k_{ijt} - \hat{\beta}_m m_{ijt} \equiv \hat{\beta}_0 + \hat{u}_{ijt}. \tag{11}$$

Following the derivation of firm-level TFP estimates, the relationship between this measure of firm-level economic performance and various firm-specific foreign R&D knowledge variables capturing the extent of foreign knowledge inherent in firms' immigrant workers can be analyzed using the following regression equation:

$$\ln\left(\widehat{TFP}_{ijt}\right) = \alpha + \beta_{\mathcal{X}}\mathcal{X}_{ijt} + \boldsymbol{Z}'_{\boldsymbol{ijt}}\boldsymbol{\beta}_{\boldsymbol{Z}} + \alpha_i + \alpha_r + \alpha_{jt} + e_{ijt}. \tag{12}$$

The variable of interest, $\mathcal{X}$, refers to our measure for the "accessible international R&D capital stock" capturing the extent of foreign R&D knowledge inherent in the firm's immigrant employees. A detailed discussion regarding the construction of this variable is provided in the next section. In addition, we also take into account a broad range of firm-specific control variables, summarized in the vector $\boldsymbol{Z}$. This includes a measure of firm-level workforce ethnic diversity, the log of average firm tenure (in years) across all employees, the share of male employees, the share of managers, the share of foreign workers, and a dummy variable indicating whether or not the firm is engaged in exporting. Furthermore, we also incorporate firm-specific controls indicating the share of employees belonging to each age distribution quartile, the share of employees with low-, medium-, high-, and military-skilled occupational positions, and the share of employees with basic, secondary, and tertiary educational status. Thus, we are able to capture differences in firm-level absorptive capacity on the employment level and thus explicitly control for the notion of prior knowledge, as suggested in Cohen and Levinthal (1989). Furthermore, the variables α_i, α_r, and α_{jt} refer to firm, region, and three-digit NACE Revision 2 industry-year fixed effects, to control for unobserved heterogeneity across firms, regions, industries, and years.

These fixed effects specifications warrant some careful discussion in order to identify the main empirical results. First, it may be that firms with a systematically better management or a superior organizational structure are more apt to hire workers with very specialized skills that also determine firm-level productivity. These firm characteristics are not likely to vary strongly over time. Thus, we address this source of endogeneity by including firm fixed effects into the regression equation. Second, we incorporate region fixed effects into the regression equation to control for differences in labor market policies, infrastructure quality, and assistance to industrial sectors across economic regions by commuting area according to Andersen (2002) that are common to all firms within the region. Third, the industry-year fixed effects remove all trends specific to the industry under consideration but are common to the firms belonging to that industry. These common trends include such factors as demand shifts and price changes, as well as differences in management skills, and industry-specific technology opportunity conditions. Moreover, these fixed effects absorb shocks common to all firms within Denmark. It is important to point out that these time dummies also capture the impact of firms' own R&D knowledge stocks and the impact of the knowledge stocks of other firms located in Denmark, which is the Danish total R&D capital stock. Furthermore, these dummies also control for economy-wide effects such as demand and productivity shocks as well as measurement errors in deflators common to all firms within that industry. Finally, e_{ijt} refers to a firm-specific error term.

To a large extent, endogeneity concerns related to the main explanatory variable indicating the extent of foreign R&D knowledge inherent in firm's immigrant workers are ameliorated by the inclusion of a wide range of additional firm-specific controls. Specifically, an important source of endogeneity is located at the firm-level. More productive firms may hire workers with very specialized skills. Because of the small size of the Danish economy, these firms may hire more workers from abroad. We control for this issue by including the share of workers with low-, medium-, high-, and military-skilled occupational positions. In addition, highly productive firms are likely to be more successful in hiring or screening qualified immigrants, as they are likely to have a greater capacity to recruit workers, as discussed in Malchow-Møller et al. (2011). This would result in a higher share of immigrants from technologically advanced countries in a given firm. These unobservable factors may be correlated with the constructed firm-specific foreign R&D knowledge variable which also determine firm-level productivity. We tackle these concerns from two sides: First, the quality of hires is likely to also depend on the composition of the management staff, which we control for in our specifications.[3] Second, systematically better hires in firms are likely to be driven by organizational advantages of the firm. These features rarely change over time and are consequently eliminated by firm fixed effects. Subsequent concerns are addressed in the robustness checks. A positive correlation between trade and migration may induce a bias due to endogeneity of our core variable. Thus, we include a trade-weighted foreign R&D knowledge variable in the regression equation. Moreover, even though international R&D capital stocks are likely to be exogenous to the individual Danish firm, it might be that some Danish Multinational Enterprises (MNEs) conduct R&D activities abroad, thereby contributing to the foreign R&D knowledge stock. Similarly to Keller (2002), we address this concern by excluding MNEs from the baseline estimation sample. Finally, we provide results including all firm-specific foreign R&D knowledge measures in the first lag specification, as they were predetermined in a way that warrants exogeneity of the variables of interest. This choice effectively restricts the estimation sample to the years 2001 to 2011. None of these modifications alter the main results significantly.

3 Approximation of Absorptive Capacity and R&D Knowledge Spillovers

The theoretical considerations of Arrow (1969), (Cohen and Levinthal, 1990), and Cohen and Levinthal (1994, p. 227) suggest that immigrants increase a firm's absorptive capacity for foreign knowledge by providing language skills, cultural backgrounds, and personal contacts to their home country. A measure approximating this theoretical argument should therefore link the employed immigrants and the R&D capital stock of their home country.

A first simple approach would be to treat employed immigrants and the R&D capital stocks of their home countries as complements. The common procedure to test for potential complementarities between employed immigrants and foreign R&D capital stock is to introduce an interaction term between the two. We therefore first interact the share of immigrant workers, as a proportion of total workers employed, with the sum of foreign R&D capital stocks from their home countries. Because R&D data is only available from OECD countries and selected non-member

[3] For example, Åslund et al. (2014) have found that managers are more likely to hire employees of a similar nationality to their own.

countries (China, Romania, Russia, Singapore, and South Africa), we limit the analysis to immigrants from these countries. Furthermore, Denmark is obviously excluded from this country selection. Hereafter we refer to these countries as $OECD^{+}$ countries,

$$\left[Share\ OECD^{+} \times \ln(s^{f,total})\right]_{it} = \left(\frac{L_{it}^{OECD^{+}}}{L_{it}}\right) \times \ln\left(\sum_{c \in OECD^{+}} \left(s_{ct}^{f}\right)\right), \tag{13}$$

where $L_{it}^{OECD^{+}}$ is the number of immigrants employed from $OECD^{+}$ countries in firm i at time t, L_{it} is the number of workers in firm i for period t, and s_{ct}^{f} is the R&D capital stock of country c at time t.

However, the simple interaction of the two variables does not cover the Arrow (1969) argument precisely. The interaction terms test whether firms with a high share of immigrant workers from $OECD^{+}$ countries and a high value of the sum of foreign R&D capital stocks across $OECD^{+}$ countries, which is equal among firms in a given year, might perform better than other firms. As the interaction term does not link the immigrants directly to the R&D capital stocks of their corresponding home countries, this actually only tests whether immigrants as such have a better ability to absorb foreign knowledge because they have, for example, better international networks or higher skills resulting from their experience working abroad. Furthermore, the interaction term between the share of immigrant workers and the sum of foreign R&D capital stocks generates cases where it indicates a high absorptive capacity of the particular firm, although the set of immigrant workers employed do not come from technologically advanced $OECD^{+}$ countries. In addition, this measure is unable to distinguish firms that employ exclusively immigrant workers from one $OECD^{+}$ country, although they might originate from countries with very different technological levels (e.g., 5 percent employees from Spain versus 5 percent employees from the US).

In a nutshell, a mere interaction between the share of immigrants and the aggregate knowledge capital stock does not capture the notion of absorptive capacity, in which the immigrants' country-specific assets such as language, culture, personal contacts, or social-ethnic networks matter crucially when assessing their home countries' R&D capital stocks. To address this important issue, in a second step we follow the argumentation of Griliches (1979) and construct a corresponding index number.[4] Griliches (1979), and building on his work, Coe and Helpman (1995) argue that knowledge spillovers occur primarily between technologically similar entities. They therefore use a weighted sum of foreign R&D capital stocks across countries to proxy for this issue. The weighting function can be interpreted as that fraction of knowledge that can effectively spill over to recipients. In the study by Coe and Helpman (1995), bilateral import shares are used as weights. For example, if country A imports a fraction δ of its total imports from country B, country B's R&D capital stock is weighted by δ. Summing up across all trade partners yields the variable of interest.[5]

We follow a slightly adjusted version of the Coe and Helpman (1995) approach to establish a direct link between the

[4] Note that country-specific interaction terms are not an option due to lack of variation.

[5] The import-weighted R&D capital stock proposed by Coe and Helpman (1995) has indeed been shown to reflect trade-related spillovers as discussed in Coe and Hoffmaister (1999) after having been questioned by Keller (1998).

absorptive capacity of firms resulting from immigrant workers and their foreign R&D knowledge stock. However, we do not model the proximity to the foreign R&D capital stock in a technical sense. Instead, we use the shares of immigrants from different countries of origin as a weighting function to account for the idea of proximity in the sense of language, culture, and personal contacts, as suggested by Arrow (1969). Thus, the fraction of the R&D knowledge stock of a foreign country effectively available to spill over is determined by the fraction of immigrants from the specific country. For example, the more immigrants a firm hires from one country than from others, the more knowledge from this country the firm can explore and potentially absorb. Here, we follow the procedure of Griliches (1979) and construct an ethnicity-weighted (hereafter denoted as ew) variable, where the weight is the share of immigrants from a certain country. Therefore, $\mathcal{X}_{ijt}$ in equation (12) then becomes:

$$\ln\left(s_{it}^{f,ew}\right) = \ln\left(\sum_{c\in OECD^+}\left(\frac{L_{ict}^{OECD^+}}{L_{ct}^{OECD^+}}s_{ct}^{f}\right)\right), \tag{14}$$

where $L_{ict}^{OECD^+}$ is the number of immigrants employed in firm i from country c at time t, and $L_{ct}^{OECD^+}$ is the number of immigrants from country c in year t across all firms i in Denmark. Moreover, s_{ct}^{f} again refers to the R&D capital stock of country c at time t, and c contains only $OECD^+$ countries. By definition, this measure is set to zero for firms employing exclusively Danish workers or immigrant workers from $Non\text{-}OECD^+$ countries. Thus, we are able to compare the economic performance of Danish firms employing immigrants from technologically advanced countries with those without such workers. It is important to note that in the share $\frac{L_{ict}^{OECD^+}}{L_{ct}^{OECD^+}}$, the denominator consists of the entire pool of immigrant workers from country c in year t across all Danish firms i $\left(L_{ct}^{OECD^+}\right)$. This choice ensures that, ceteris paribus, firms with a higher share of immigrants from technologically advanced countries (here approximated by size of the foreign R&D capital stock) have a larger $\ln\left(s_{it}^{f,ew}\right)$ value and vice versa. For example, a firm employing only one immigrant from, say, Germany will have a lower absorptive capacity than a firm with two immigrants, both from Germany. Hence, the index precisely captures the notion that the firm with two immigrants is able to absorb more foreign R&D knowledge from Germany.

A comparison between the aforementioned interaction term and the ethnicity-weighted foreign R&D knowledge variable indeed shows that the latter captures Arrow (1969) arguments better. To substantiate this point, Figure 1 shows the relationship between the ethnicity-weighted foreign R&D knowledge variable and the stock of foreign employees, classified into four quantiles, and constructed for the year 2010. For the sake of simplicity, this figure was restricted to firms employing immigrants exclusively from a single $OECD^+$ country with positive values for our preferred foreign R&D knowledge variable $\ln\left(s^{f,ew}\right)$. The figure indicates that there exists great variation in our ethnicity-weighted foreign R&D knowledge measure in each quantile. This observation provides positive evidence that the interaction term is unable to link the absorptive capacity of immigrant workers to their country-of-origin R&D knowledge stock. As a specific example, consider two firms in the fourth quantile with a total labor stock of ten workers, each employing one immigrant from an $OECD^+$ country. The only difference is that one firm employs one immigrant from Turkey whereas the other firm employs one immigrant from Germany. According to our interaction

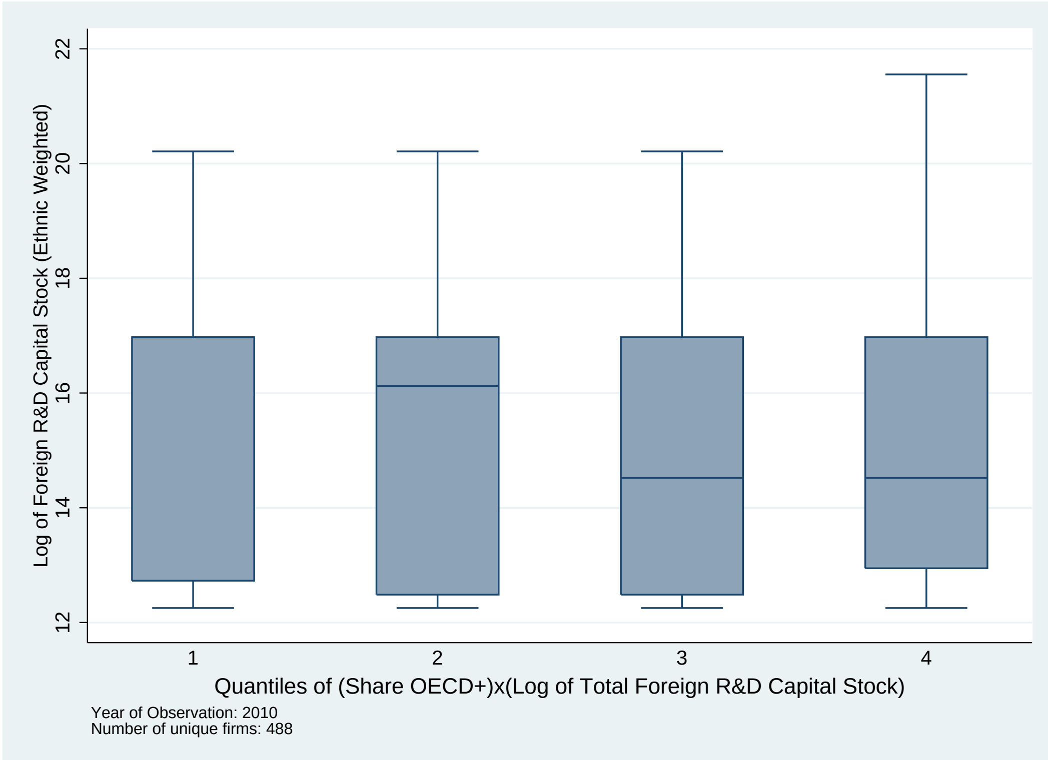

Figure 1: Boxplot of $\ln\left(s^{f,ew}\right)$ and $\left[(Share\ OECD^{+}) \times \ln\left(s^{f,total}\right)\right]$ for the year 2010

term, both firms are considered to have access to the same foreign R&D knowledge stock (about 2.92 log points). However, we would expect that firms employing immigrants from more technologically advanced countries should also have access to a much larger foreign R&D knowledge stock. Our ethnicity-weighted foreign R&D knowledge measure captures this notion precisely as it indicates that the firm with the German worker has access to a much larger foreign knowledge stock (about 16.97 log points) than the firm employing one worker from Turkey (about 12.49 log points). Therefore, to circumvent the aforementioned disadvantages related to the interaction term variable, the subsequent analysis utilizes our preferred firm-specific ethnicity-weighted foreign R&D knowledge index in the regression analysis, which precisely captures the knowledge possessed by the firm's immigrant employees.

Furthermore, as the acquisition of foreign knowledge also requires prior technological knowledge, the educational level of employed immigrants is likely to influence the absorptive capacity of a firm. We therefore differentiate the immigrant workforce by educational level. Using equation (14), five separate variables for immigrants with basic, secondary, tertiary, unclassified, and unknown educational status are constructed. As an example, the foreign R&D variable $\ln\left(s_{it}^{f,eweduc,basic\ education}\right)$ then includes only immigrants from $OECD^{+}$ countries with a basic level of education.

Furthermore, particularly for immigrants, the occupational position might not correspond to the educational status, e.g., due to problems with the recognition of foreign educational qualifications. In particular, Bosetti et al. (2015)

found that an education-based diversity measure underestimates the contribution of skilled immigrants to the creation of knowledge as compared to an occupation-based measure. Consequently, employees might not work in an occupational position in accordance with their educational status. More importantly, Nielsen (2011) stress that immigrant workers may suffer from problems with the recognition of foreign educational qualifications, resulting in a lower occupational position, even though the opposite mismatch may also occur. Indeed, a non-negligible share of immigrant workers from $OECD^+$ countries used in the regression analysis have an unknown educational status. Furthermore, the educational status approximates the inherent human capital at the beginning of a career, neglecting advances in human capital through, for example, on-the-job training. In contrast, the occupational position provides an accurate assessment of the employees' actual activities within the firm, which may be a closer approximation of the convention of absorptive capacity. Therefore, we construct an ethnicity-weighted foreign R&D knowledge variable for immigrants with various occupational positions. It is again constructed according to the procedure of Griliches (1979) as laid out in equation (14), where the weight this time is the share of immigrant workers in a certain occupational position:

$$\ln\left(s_{it}^{f,ewoccu,\phi}\right) = \ln\left(\sum_{c\in OECD^+}\left(\frac{L_{ict}^{OECD^+,\phi}}{L_{ct}^{OECD^+}} s_{ct}^f\right)\right). \tag{15}$$

The variable $L_{ict}^{OECD^+,\phi}$ is the number of persons employed by firm i from country c with occupational position $\phi = (low-skilled, medium-skilled, high-skilled, managers, military-skilled, unknown-skilled)$ at time t. Thus, $\ln\left(s_{it}^{f,ewoccu,\phi}\right)$ represents the ethnicity-weighted foreign R&D knowledge variable that is accessible to a firm through its immigrant workers with occupational position ϕ. According to this definition, ceteris paribus, firms with a higher share of immigrants from technologically advanced countries (again approximated by size of the foreign R&D capital stock) also have a larger $\ln\left(s_{it}^{f,ewoccu,\phi}\right)$ value and vice versa.

4 Data and Variables

4.1 Data Description

In evaluating the impact of knowledge spillovers on firm-level TFP through firms' employment of immigrant workers, this study utilizes a longitudinal linked employer-employee data set provided by Statistics Denmark from a variety of statistical registers.

The starting point in data preparation is the Integrated Database for Labor Market Research (henceforth referred to as IDA). IDA contains information on the personal, employee, and workplace level for any given year. It provides valuable information on a wide range of individual characteristics, containing, for instance, gender, date of birth, country of origin, educational background, labor market experience, earnings, and current occupational position on every individual living in Denmark from 1980 to 2012. The main variables of interest are country of origin, educational background, and occupational position.

The second statistical register employed in the analysis is the Firm Integrated Database for Labor Market Research (henceforth referred as FIDA). The main purpose of FIDA is to assign each employed person in Denmark to a firm based on a unique firm identification number. The assignments between persons and firms are uniquely identified each year at the end of November. Since FIDA covers both full- and part-time employment positions, we treat each of the miscellaneous jobs held by an individual in different firms as a single separate job. Once IDA has been linked to FIDA, the compiled information on each individual is then aggregated to obtain firm-specific variables, such as the number of employees (head counts), average firm tenure (in years) across employees, shares of age distribution quartiles, shares of males, managers, foreigners, and the shares of workers having different educational statuses and occupational positions. Based on each individual's country of origin, a variable is calculated that reflects firm-level workforce ethnic diversity using a slight variation of the Herfindahl-Hirschman concentration index (Alesina et al., 2003).

The third statistical register REGNSKAB provides business accounts data, from which we extract such variables as gross production (total sales of goods and services), intermediate goods (purchase as goods, supplementary materials, and packaging, excluding energy costs), capital stock (fixed assets), industrial classification (NACE Revision 2), and municipality code. REGNSKAB covers the construction and retail trade industries at the firm level since 1994, manufacturing industries since 1995, wholesale trade since 1998, and the remaining private industries since 1999. We use the general firm statistics from 2000 onwards because of an obvious break in the data in the year 1999 (Timmermans, 2010). We prefer the firm accounting statistical register REGNSKAB over the general firm statistical register FIRM. Although the latter provides information for a much larger number of firms, it contains missing observations for the variable intermediate inputs in the years 1999 to 2001. But this variable is critical for the estimation of firm-level TFP measures.

The fourth statistical register UHDI contains information on firm-level foreign trade activities. This statistical register provides detailed information on bilateral import and export sales with information on destination markets and traded products based on an eight-digit classification scheme. We use this additional data source to construct an import- and export-weighted foreign R&D knowledge variable to test the robustness of our main results to trade-related knowledge spillovers.

Finally, the data for the construction of international R&D capital stocks in 39 countries is provided by the OECD's Analytical Business Enterprise Research and Development (ANBERD) database. This database covers information on R&D expenditures for OECD countries and selected non-member countries (China, Romania, Russia, Singapore, and South Africa).[6]

[6]See Table 1 for a list of countries included in the empirical analysis. Furthermore, we also provide a more formal discussion in the construction of international R&D capital stocks for the sampled $OECD^+$ countries in the Appendix.

4.2 Descriptive Statistics

Before proceeding to the discussion of descriptive statistics for workers and firms, it is worth mentioning that firms with an average workforce of fewer than 10 employees per year between the period 2000 and 2011 have been removed from the empirical analysis. This ensures a certain degree of variability of immigrant employees across firms when constructing various firm-specific foreign R&D knowledge variables and facilitates the reliability of the main empirical findings. Overall, this results in the exclusion of 17,675 firms corresponding to 84,829 firm-year observations during the period 2001 and 2011.[7]

Table 3 reports descriptive statistics on firms the sample used in the regression analysis. We subdivide the sample into three main categories: firms employing exclusively Danish workers, firms employing Danish and immigrant workers, and firms employing at least one immigrant worker from an $OECD^{+}$ country. A closer inspection of the statistics reveal that firms employing immigrant employees (either from $OECD^{+}$ or $Non\text{-}OECD^{+}$ countries) are on average more productive and have higher values for gross production, labor, materials, and capital than firms employing exclusively Danish workers. Although firms with immigrant employees are older on average than firms with exclusively Danish workers, these firms have higher shares of workers with tertiary educational status and high-skilled occupational positions on average.

Table 4 lists descriptive statistics on workers' characteristics included in the regression analysis. During the period 2001 and 2011 there were about 3,517,458 worker-year observations, of which 3,257,529 were Danish and 259,929 were non-Danish. About 48.27 percent of the non-Danish worker-year observations are from $OECD^{+}$ countries. In comparison to Danish workers, an average $OECD^{+}$ worker seems to be less tied to the firm, as indicated by the tenure variable. Furthermore, these workers have on average a higher tertiary educational status than Danish workers. In terms of occupational positions, $OECD^{+}$ workers are comparable to their Danish counterparts, even though these workers have a higher share of low-skilled occupations. To facilitate the interpretation of the empirical findings, it is important to discuss the unexpected high share of $OECD^{+}$ workers with an unknown educational status. Table 5 lists these workers by occupational positions. About 23,940 $OECD^{+}$ worker-year observations are classified as having an unknown educational status. However, these are mainly workers with low- to medium-skilled occupational positions. For completeness, Table 6 lists the number of $OECD^{+}$ workers with unclassified educational status. This corresponds to 242 worker-year observations, of which 72.31 percent have a high-skilled occupational position.

Finally, Table 7 and 8 report descriptive statistics and the correlation matrix for the main firm variables employed in the regression analysis, respectively.

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[7] See Table 2 for a detailed data description of the firms excluded from the regression analysis. However, the qualitative results are not sensitive to the inclusion of firms with fewer than 10 employees on average per year during the period 2000 and 2011.

5 Empirical Results

Table 10 presents the first results on the relationship between firm-level TFP and the absorption of foreign knowledge if firms employ foreign workers.

The results reported in column (1), include the variable denoted *Share* $OECD^+$ that refers to the share of foreign workers from $OECD^+$ countries as a proportion of total workers employed. The coefficient associated with the $OECD^+$ variable is insignificant. However, the imprecise estimate may be due to various confounding effects on the potential costs and benefits associated with the presence of foreign workers on firm-level TFP. Thus, column (2) includes an interaction term between the share of foreign workers from $OECD^+$ countries and the log value of the sum of international R&D capital stocks for the sampled $OECD^+$ countries. Interestingly, the estimated coefficient associated with the interaction term is of the expected positive sign and statistically significant at the 1 percent level, whereas the impact of the foreigner share turns negative and statistically significant at the 1 percent level as well. The results indicate that employing immigrants from $OECD^+$ countries contribute significantly to firm-level TFP through an improved access to foreign R&D knowledge stocks. To test if the results are driven by the international R&D stocks or by the share of immigrants from $OECD^+$ countries, we repeat the exercise, this time using the share of immigrants from *Non-*$OECD^+$ over total workers employed. By this we are also testing whether immigrants who have no connection to the interacted R&D capital stocks and thus cannot provide the skills discussed above (e.g., language, culture) required to absorb the knowledge could still help the firm to make use of that knowledge. A positive coefficient would indicate, that more general characteristics of immigrants, such as better international networks or higher skills resulting from their experience working abroad. Turning to the estimates for immigrants from *Non-*$OECD^+$ countries, we see an interesting pattern. First and foremost, the mere employment of immigrants from *Non-*$OECD^+$ countries *does* contributes significantly to firm-level TFP, as shown in column (3). This result is consistent with the general notion that immigrants with a different cultural background may contribute to firm-level TFP through, for example, improved problem-solving abilities (Hong and Page, 2001, 2004). However, the results in column (4) reveals that immigrants from *Non-*$OECD^+$ countries are unable to improve firm-level TFP through improved access to foreign R&D knowledge stocks. Furthermore, the coefficient of *Share Non-*$OECD^+$ becomes negative and is rendered insignificant. Finally, column (5) includes all variables for immigrants from $OECD^+$ and *Non-*$OECD^+$ countries, identifying the most important variables that contributes significantly to firm-level TFP. The key implication from this specification is that only immigrants from $OECD^+$ countries affect firm-level TFP through a higher absorption of foreign R&D knowledge stocks.

Table 11 provides the first results on the relationship between firm-level TFP and the ethnicity-weighted foreign R&D knowledge variable, also examining the influence of the immigrants' educational status. In column (1) the ethnicity-weighted foreign R&D knowledge measure is introduced into the regression equation. The coefficient is highly statistically significant and confirms our assumption that firms benefit from the employment of immigrants from technologically advanced countries through the absorbed foreign R&D knowledge. In addition, we assess the impact of the immigrants' educational status for each educational level separately, as shown in columns (2) to (5). The specification in column (2) considers the foreign R&D knowledge measure restricted to immigrant workers from $OECD^+$ countries with only a basic level of education. However, the contribution to overall firm-level TFP for this educational group is not statistically different from zero. In columns (3) and (4) we assess the impact of immigrant workers from $OECD^+$ countries with secondary and tertiary educational status, respectively, on firm-level TFP. The results suggest that immigrant workers with secondary or tertiary education from $OECD^+$ countries both offer a positive markup on the output elasticity of foreign R&D knowledge vis-à-vis firms employing Danish and $Non\text{-}OECD^+$ workers. The results in column (5) show the impact of immigrant workers from $OECD^+$ countries with an unclassified and unknown educational status. As discussed above, a large proportion of these immigrant workers perform low- and medium-skilled occupational tasks. Thus, we expect that their impact on firm-level TFP should be similar to that of immigrant workers with a basic level of education. Indeed, neither of the two variables enter statistically significantly into the regression equation. Finally, the results remain robust when including all the various education-related foreign R&D knowledge variables into one specification, as shown in column (6).[8]

It should be noted that the estimated elasticities of immigrant workers from $OECD^+$ countries with a secondary and tertiary educational status are comparable in terms of their economic magnitudes, although we would expect – in line with the empirical findings in Stoyanov and Zubanov (2012) – that immigrants with the highest possible level of education would play a more pronounced role in the absorption of foreign R&D knowledge. In this regard, we provide a more disaggregated analysis of immigrant workers from $OECD^+$ countries with secondary and tertiary education. Specifically, we disaggregate the secondary educational status into lower-, upper-, and post-secondary education. Furthermore, the tertiary educational status now consists of short-cycle tertiary, bachelor, master, and doctoral education. The corresponding results are shown in Table 12. When we look specifically at the last specification in column (6),we see that the highest contribution to firm-level TFP is offered by immigrant workers from $OECD^+$ countries with a master's degree, followed by immigrant workers with short-cycle tertiary, upper-secondary, and lower-secondary education. For example, the estimates suggest that, ceteris paribus, an increase in the ethnicity-weighted foreign R&D knowledge variable accessible through immigrant workers from $OECD^+$ countries with a master's degree (either due to a change in foreign employment or variation in the foreign R&D capital stock) by 1 percent increases firm-level TFP by 0.0070 percent.

As discussed earlier in the paper, it is likely that education does not measure immigrants' skill levels properly. We therefore introduce ethnic occupation-weighted measures into the equation to test for this issue. The corresponding

[8] We further differentiate the educational aspect of the absorptive capacity by constructing an ethnicity-education-duration-weighted measure of foreign R&D knowledge for each firm and year. In this regard, for each immigrant worker, we construct the theoretical cumulative duration in years required to attain a basic, secondary, and tertiary educational status based on the International Standard Classification of Education (ISCED), as reported by the United Nations Educational, Scientific and Cultural Organization (UNESCO). The results are qualitatively similar to those reported for the ethnicity-weighted foreign R&D knowledge variable and shown in Table 16 in the Appendix.

results are shown in Table 13. In each column (1) to (5), we subsequently introduce one of the various foreign R&D knowledge measures for immigrant workers from $OECD^{+}$ countries with low-skilled, medium-skilled, high-skilled, managerial, military-skilled, and unknown-skilled occupational positions. The results obtained from these specifications suggest that only the foreign knowledge inherent in immigrants from $OECD^{+}$ countries with low- and high-skilled occupational positions contribute individually and significantly to overall firm-level TFP. The results presented in column (6) evaluate the overall significance of the various foreign R&D occupational position measures when included simultaneously in the regression equation. It follows that the highest contribution is generated by immigrants with high-skilled occupational positions, which is highly statistically significant at the 1 percent level, followed by immigrant workers with low-skilled occupational positions. In addition, the contribution of immigrant workers with a medium-skilled, managerial position, military-skilled, and unknown-skilled occupational position is not statistically significant. Taken together, these findings are consistent with a recent paper by Parrotta and Pozolli (2012) showing that highly educated technicians are knowledge carriers. They also relate directly to the contribution of Arrow (1969) that both prior technical knowledge (e.g., high-skilled workers) and non-technical skills (e.g., low-skilled workers) are ingredients in successful knowledge transmission. In quantitative terms, the results suggest that, ceteris paribus, a 1 percent increase in the ethnicity-weighted foreign R&D knowledge variable accessible through immigrant workers from $OECD^{+}$ countries with a high-skilled occupational position – whether due to a change in foreign employment or to variation in the foreign R&D capital stock – increases firm-level TFP by about 0.0015 percent.

Finally, the positive influence of immigrant workers on firms' TFP resulting from an increased absorptive capacity should be discussed in connection with the two other control variables that capture further effects of immigrant workers. The first of these is the firm-level workforce ethnic diversity measure, which corresponds to the probability that two randomly selected workers in a particular firm and year differ with respect to their country of origin, with higher values corresponding to a more ethnically diverse labor force. The other is the simple share of foreigners over the total number of persons employed ($Share\ Foreigner$). Interestingly, firms employing more foreigners have on average higher TFP outcomes, while the impact of the firm-level workforce ethnic diversity measure is negative and both are highly statistically significant throughout the empirical analysis. Prior research has established a negative effect of ethnic diversity on firm-level TFP (Parrotta et al., 2014a). The main argument for this finding is, that ethnic diversity is accompanied by both costs and benefits for firm-level economic performance. The negative effect is transmitted through higher communication costs and lower interpersonal trust, whereas the positive effect is transmitted through enhanced innovation activity (Alesina and La Ferrara, 2005). Thus, the results show that it is not the percentage of foreigners that negatively affects firm-level TFP but rather the composition of the workforce of immigrants from different countries, as captured by the workforce ethnic diversity measure. In contrast to the negative impact of workforce ethnic diversity on firm-level TFP, the results reported in this paper suggest, on the other hand, that firms benefit from an ethnically diverse labor force by gaining an increased absorptive capacity to acquire foreign R&D knowledge – which is fully in line with the positive impact of ethnic diversity on innovative activity found by Parrotta et al. (2014b).[9]

6 Robustness Analysis

This section establishes the robustness of the main results to different sample sizes, model specifications, and alternative production function estimators. The corresponding results are shown in Table 14. The specification in column (1) reproduces the main results using the definition in equation (14) for the ethnicity-weighted foreign R&D knowledge variable. This specification corresponds to that in column (1), Table 11, and is shown for comparison purposes.

Non-exporters benefit more. The results reported in column (2) restrict the analysis to non-exporting firms. This specification leads to the exclusion of 34,241 firm-year observations from the baseline estimation sample. The exclusion of exporters from the base sample to some extent alleviates knowledge spillovers triggered, for example, by export sales. Reassuringly, the estimates are not sensitive to the exclusion of exporters from the estimation sample. In contrast, the estimated coefficient associated with the ethnicity-weighted foreign R&D knowledge variable increases to about 0.0011 and is statistically significant at the 5% level. This result suggests that non-exporters benefit more from immigrant workers than exporting firms. One possible reason for the importance of immigrants to non-exporters could be that they function as possible substitutes for international technology diffusion by exports.

Results are not driven by MNEs. Furthermore, column (3) maintains the robustness of the main results to the exclusion of multinational enterprises (MNEs), which might be particularly good at absorbing international knowledge spillovers due to their international structure and could therefore be driving the main results in our empirical analysis. The estimated coefficient associated with the ethnicity-weighted foreign R&D knowledge variable, however, retains its positive sign and still is highly statistically significant at the 1% level. This observation suggests that the previous results are not driven by R&D investments of Danish multinational companies abroad.

Not only high-technology firms benefit. Case studies have shown the importance of technology diffusion for the high-technology pharmaceutical and computer industries. For this reason, Keller (2004, p. 761) argues that endogeneity concerns are more pronounced in R&D-intense industries. Column (4), therefore, assesses the robustness of the results, excluding the high-technology chemical industry (which includes the pharmaceutical industry) and the computer industry from the baseline estimation sample. The estimated coefficient associated with the ethnicity-weighted foreign R&D knowledge variable remains positive and is statistically significant at the 1 percent level. Thus, the main results in the empirical analysis are not driven by these industries.

[9] A more thorough analysis of the potential costs and benefits of an ethnically diverse workforce on firm-level TFP is, however, beyond the scope of the current paper and is left for future research.

***Non-OECD*$^{+}$ foreigners do not confound the estimates.** As a further robustness check, the results shown in column (5) is based on a sample excluding observations of firms employing foreign workers from *Non-OECD*$^{+}$ countries only. Therefore, the estimated coefficient on the ethnicity-weighted foreign R&D knowledge variable then indicates the impact on firm-level TFP for firms employing at least one immigrant worker from an $OECD^{+}$ country in comparison to firms employing exclusively Danish workers. This criterion restricts the analysis to $41,489$ firm-year observations. However, the estimated coefficient on the ethnicity-weighted foreign R&D capital stock variable is positive and increases substantially to about 0.0012, which is statistically significant at the 1 percent level.

Results are not sensitive to trade-related knowledge spillovers. Furthermore, to rule out the possibility that the ethnicity-weighted foreign R&D knowledge measure captures knowledge spillovers triggered by trade relationships, the specification in column (6) includes an import- and export-weighted foreign R&D knowledge variable into the regression equation. Specifically, the two latter variables are constructed according to expression $\sum_{c \in T_{it}} \left(\zeta_{ict} s^{f}_{ct} \right)$, where ζ_{ict} refers to the bilateral import share of a firm's i trading partner countries in year t in one case $\ln\left(s^{f,trade-spillover,imports}\right)$ and the bilateral export share in the other $\ln\left(s^{f,trade-spillover,exports}\right)$. In addition, T_{it} is the set of firm's i trading partners in year t. This specification excludes $23,235$ firm-year observations from the baseline estimation sample. However, the qualitative results remain unchanged following the inclusion of trade-related foreign R&D knowledge variables, of which both are statistically insignificant.

Different production function estimators lead to the same qualitative conclusions. In the following, the robustness of the main results is examined using alternative production function estimators in the calculation of firm-level TFP. The corresponding results are shown in Table 15. Column (1) shows the main results of our preferred baseline Wooldridge (2009) estimation method and is, again, reported for comparison purposes. In column (2), firm-level TFP estimates are obtained from the Wooldridge (2009) method based on the Olley and Pakes (1996) approach using investment as the proxy for the unobserved productivity shock (WOP estimator). The estimated coefficient associated with the ethnicity-weighted foreign R&D knowledge variable drops considerably, but is still statistically significant at the 5 percent level. In column (3), we obtain firm-level TFP estimates using the Levinsohn and Petrin (2003) semi-parametric estimation approach (LP estimator). In contrast to the baseline Wooldridge (2009) method, we find a much higher coefficient estimate for the ethnicity-weighted foreign R&D knowledge variable. The main results are further confirmed when estimating a Cobb-Douglas production function by OLS with firm fixed effects and time-varying firm fixed effects across four time periods (2000-2002, 2003-2005, 2006-2008, 2009-2011). The corresponding results are shown in columns (3) and (4), respectively. Some disadvantages of Cobb-Douglas production function specifications are that the estimated elasticities are restricted to be constant, that all firms have the same production function elasticities, and that the substitution elasticities are restricted to equal 1. To ensure a more flexible production function specification concerning the output and substitution elasticities with respect to the traditional input factors for labor, materials, and capital, we estimate a second-order translog production function by OLS with, again, time-varying firm fixed effects. The results are shown in column (6). Reassuringly, the main results are not sensitive to this production function specification. In contrast to the baseline results, the estimated coefficient associated with the ethnicity-weighted foreign R&D knowledge variable increases substantially in magnitude and remains highly statistically significant at the 1 percent level.

7 Conclusion

If immigrant workers are hired, they bring with them specific knowledge on the culture and language of their home countries, as well as links to their social networks. Both of these increase a firm's absorptive capacity. In this paper, we therefore analyzed whether immigrant workers increase a firm's TFP by extending its absorptive capacity for technological knowledge from the immigrants' home countries. Based on a Danish matched employer-employee data set for manufacturing industries covering the period 2000 to 2011, we constructed various measures that link firms' immigrant workers to the R&D knowledge stocks of their respective countries of origin. The TFP estimations show that immigrant workers increase firms' capacity to absorb foreign R&D knowledge, which contributes significantly to overall firm-level TFP. Furthermore, we find that this impact increases with both the educational status and occupational position of immigrant workers. However, we do not find such an impact for immigrants managers.

The main TFP results are robust to a wide range of additional firm-specific controls and various model specifications. For example, the results are not sensitive to the exclusion of exporters, multinationals, or high-technology firms, which may be quite successful in their absorption of international R&D knowledge stocks. Furthermore, we show that the impact of foreign knowledge inherent in firms' immigrant employees on firm-level TFP is not confounded with trade-related knowledge spillovers, as we explicitly control for this issue in the robustness analysis. In addition, the main results are further confirmed based on different production function estimators used to derive firm-level TFP measures.

Even though an ethnically diverse workforce reduces firm-level TFP, it simultaneously improves firms' economic performance by increasing their absorptive capacity to acquire foreign knowledge. At the same time, the positive impact of an ethnically diverse labor force for firms' capability to access foreign knowledge through culture, language, and social networks might increase communication costs and reduce interpersonal trust, resulting simultaneously in a negative impact on firm-level TFP. However, a more detailed assessment of potential costs and benefits of ethnic diversity in a unified econometric framework is beyond the scope of the paper and has to be left to future research.

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A The Construction of International R&D Capital Stocks

Data for the construction of international R&D capital stocks in 39 OECD countries and selected non-member countries (China, Romania, Russia, Singapore, and South Africa) is provided by the OECD's Analytical Business Enterprise Research and Development (ANBERD) database, available online at http://stats.oecd.org/Index.aspx?DataSetCode=ANBERD_REV4. In order to increase the number of observations per country, we combine the newly available ANBERD data in ISIC Rev. 4 with those from ANBERD ISIC Rev. 3 (update 2011). Differences in industry classifications were of minor interest here, since we focused on R&D expenditures at the country rather than the industry level. Data on R&D expenditures were first deflated by a country-specific GDP price deflator provided by the World Bank *World Development Indicators* and then converted into constant 2000 US dollars.

The construction of the R&D capital stock for each country was then carried out following the Perpetual Inventory Method (PIM).[10] Specifically, the R&D capital stock evolves according to the following equation:

$$s^f_{ct} = (1-\delta)s^f_{ct-1} + R\&D_{ct}, \tag{16}$$

where s^f_{ct} is the $R\&D$ capital stock of country c in period t and $R\&D_{ct}$ is the flow of real $R\&D$ expenditures of country c in period t. To apply this equation to data on real $R\&D$ expenditures, two crucial decisions with respect to the depreciation rate δ and the initial capital stock must be made. The depreciation rate is assumed to be 10%, the same across countries, and constant over time. Furthermore, assuming a constant country-specific growth rate of g_c for the $R\&D$ capital stock before period $t = 1$, the value for the initial $R\&D$ capital stock is computed according to the following expression:

$$\begin{aligned} s^f_{c1} &= R\&D_{c0} + (1-\delta)R\&D_{c-1} + (1-\delta)^2 R\&D_{c-2} + \cdots \\ &= \sum_{s=0}^{\infty}(1-\delta)^s R\&D_{c-s} = R\&D_{c0}\sum_{s=0}^{\infty}\left[\frac{1-\delta}{1+g_c}\right]^s = \frac{R\&D_{c0}}{\delta+g_c}. \end{aligned} \tag{17}$$

In contrast to other studies, which assume a constant growth rate (Hall and Mairesse, 1995) for g_c, in this study g_c was computed using an average geometric growth rate in years for which data on R&D expenditures are available. Summary statistics on the R&D capital stocks of the different countries is given in Table 1.

In addition to the construction of the $R\&D$ capital stocks, countries follow different approaches in reporting their R&D expenditures. The large majority of countries report R&D expenditures using the main activity approach, whereas for some countries (e.g., Belgium, France, and United Kingdom) longer time series are only available using the product field approach. Hence, we employ the approach generating the largest number of observations per country when constructing the R&D capital stocks by the PIM method.

[10] Hulten (1991) provides an extensive discussion of the PIM for the measurement and construction of physical and human capital stocks.

Table 1: Descriptive Statistics for International R&D Capital Stocks from $OECD^+$ Countries

Country Code	Country	$OECD^+$	Obs.	Coverage	Mean	Median	S.D.	Min.	Max.
AUS	Australia	1	25	1987-2011	21447.30	17869.37	12221.12	6990.07	47102.19
AUT	Austria	1	14	1998-2011	20961.02	20375.22	5892.34	12525.88	30461.34
BEL	Belgium	1	25	1987-2011	22272.73	21999.78	5554.00	14174.61	31573.60
CAN	Canada	1	27	1987-2013	54696.91	52919.27	17691.55	30888.02	78738.05
CHE	Switzerland	1	24	1989-2012	43743.95	41500.10	6437.02	36415.39	56715.71
CHL	Chile	1	2	2007-2008	282.36	282.36	103.67	209.06	355.66
CHN	China	1	23	1991-2013	71454.45	33640.80	81331.00	4776.48	279864.31
CZE	Czech Republic	1	22	1991-2012	4838.31	4752.01	400.67	4386.81	5723.72
DEU	Germany	1	26	1987-2012	264564.91	254921.36	41056.50	204713.88	344850.66
DNK	Denmark	1	4	2009-2012	43552.90	43493.96	1161.24	42260.60	44963.07
ESP	Spain	1	26	1987-2012	20431.08	17378.49	9623.34	8066.97	38835.14
EST	Estonia	1	15	1998-2012	149.79	105.99	133.23	15.72	446.11
FIN	Finland	1	26	1987-2012	15702.18	13819.57	8315.11	5613.47	30109.10
FRA	France	1	26	1987-2012	145906.58	145926.64	26417.49	100721.52	189066.70
GBR	United Kingdom	1	26	1987-2012	157421.84	153893.98	12461.22	139532.91	180336.31
GRC	Greece	1	20	1988-2007	1011.95	878.93	505.13	385.07	1938.83
HUN	Hungary	1	19	1994-2012	1358.69	1180.05	610.34	658.11	2657.60
IRL	Ireland	1	25	1987-2011	4293.39	4034.85	2666.27	924.16	9402.28
ISL	Iceland	1	23	1987-2009	421.13	248.29	385.33	30.18	1165.89
ISR	Israel	1	22	1991-2012	21237.99	19767.87	13316.39	4897.70	45089.25
ITA	Italy	1	22	1991-2012	58047.57	56484.00	3643.37	54815.97	66892.58
JPN	Japan	1	27	1987-2013	824137.19	800920.94	211738.27	487687.78	1169614.38
KOR	South Korea	1	19	1995-2013	86455.90	75917.24	40735.84	37428.04	171099.16
LUX	Luxembourg	1	10	2000-2009	2990.84	2984.49	152.38	2767.85	3204.62
MEX	Mexico	1	17	1995-2011	4944.75	4277.21	2873.89	1312.81	9648.09
NLD	Netherlands	1	26	1987-2012	32565.99	32251.00	4358.45	26535.37	40579.00
NOR	Norway	1	26	1987-2012	12402.50	12315.50	1928.59	9809.51	15466.97
NZL	New Zealand	1	23	1989-2011	1403.64	1161.69	660.38	645.42	2704.39
POL	Poland	1	19	1994-2012	2996.76	2974.05	546.20	2043.81	4291.53
PRT	Portugal	1	26	1987-2012	1729.33	1059.30	1515.35	324.76	5280.69
ROU	Romania	1	20	1993-2012	2643.75	2426.74	872.21	1576.55	4211.61
RUS	Russia	1	15	1995-2009	13919.47	13585.43	4037.29	8365.06	20473.29
SGP	Singapore	1	18	1994-2011	7586.72	6791.18	4291.89	2093.70	15134.92
SVK	Slovakia	1	20	1994-2013	981.18	1007.26	113.31	692.28	1157.92
SVN	Slovenia	1	18	1995-2012	1108.86	1018.39	491.85	501.45	2179.61
SWE	Sweden	1	7	2007-2013	75232.12	75177.50	454.81	74741.01	75983.91
TUR	Turkey	1	24	1990-2013	3286.92	2522.21	2647.69	478.47	9762.18
USA	United States	1	25	1987-2011	1416122.38	1379397.75	302660.47	993008.88	1947659.13
ZAF	South Africa	1	23	1987-2009	3607.30	3229.44	1325.40	1933.49	6381.76

Notes: The construction of the R&D capital stocks is based on the Perpetual Inventory Method (PIM) applied to data for R&D expenditures from the OECD's Analytical Business Enterprise Research and Development (ANBERD) database, as outlined in the main text. R&D expenditures by country are first deflated with a country-specific GDP price deflator from the World Bank *World Development Indicators* and then converted into constant 2000 US-Dollars. The values in this table are expressed in millions of constant 2000 US-Dollars. The indicator $OECD^+$ refers to OECD countries and selected non-member countries (China, Romania, Russia, Singapore, and South Africa).

B Data Description

Table 2: Summary Statistics and Data Description of Excluded Firms with < 10 Employees on Average Covering the Years 2001 to 2011

Variable	Description	Mean	S.D.	Min.	Max.
ln(*Gross Production*)	The log of firm-level gross production as total sales of goods and services (in 1,000 DKK).	7.4822	1.1028	1.7918	12.2211
ln(*Labor*)	The log of firm-level workforce (head counts).	0.8971	0.8229	0	3.7136
ln(*Materials*)	The log of firm-level intermediate goods (purchase of goods, supplementary materials, and packaging, excluding energy) (in 1,000 DKK).	6.3930	1.3592	0	12.1700
ln(*Capital*)	The log of firm-level fixed assets (in 1,000 DKK).	6.0043	1.5202	0	13.4720
Share Foreigner	Foreign workers, as a proportion of total workers employed.	0.0499	0.1694	0	1
Share $OECD^{+}$	Share of foreign workers from OECD countries and selected non-member countries (China, Romania, Russia, Singapore, and South Africa), as a proportion of total workers employed.	0.0287	0.1301	0	1
Share $Non\text{-}OECD^{+}$	Share of foreign workers from $Non\text{-}OECD^{+}$ countries, as a proportion of total workers employed.	0.0212	0.1087	0	1
Workforce Ethnic Diversity	Firm-level workforce ethnic diversity measure.	0.0403	0.1226	0	0.8438
ln(*Average Firm Tenure*)	The log of average firm tenure (in years) across all employees.	1.6437	0.6226	0	2.8332
Share Males	Men, as a proportion of total workers employed.	0.7615	0.3190	0	1
Share Managers	Managers, according to Statistics Denmark's definitions based on ISCO, as a proportion of total workers employed.	0.0429	0.1635	0	1
Exporter	Dummy variable that takes value 1 if the firm exports and zero otherwise.	0.2747	0.4464	0	1
Age15_29	Workers aged between 15 and 29, as a proportion of total workers employed.	0.1405	0.2330	0	1
Age30_40	Workers aged between 30 and 40, as a proportion of total workers employed.	0.2442	0.3284	0	1
Age41_50	Workers aged between 41 and 50, as a proportion of total workers employed.	0.2718	0.3484	0	1
Age51_65	Workers aged between 51 and 65, as a proportion of total workers employed.	0.3435	0.3841	0	1
Basic Education	Workers with basic education, as a proportion of total workers employed.	0.2528	0.3225	0	1
Secondary Education	Workers with secondary education, as a proportion of total workers employed.	0.6295	0.3666	0	1
Tertiary Education	Workers with tertiary education, as a proportion of total workers employed.	0.1043	0.2399	0	1
Unclassified Education	Workers with unclassified education, as a proportion of total workers employed.	0.0024	0.0390	0	1
Unknown Education	Workers with unknown education, as a proportion of total workers employed.	0.0110	0.0737	0	1
Low-Skilled	Workers with low-skilled occupation according to the definition of ISCO, as a proportion of total workers employed.	0.2210	0.3296	0	1
Medium-skilled	Workers with medium-skilled occupation according to the definition of ISCO, as a proportion of total workers employed.	0.5501	0.3885	0	1
High-Skilled	Workers with high-skilled occupation according to the definition of ISCO, as a proportion of total workers employed.	0.0635	0.1805	0	1
Military-Skilled	Workers with military-skilled occupation according to the definition of ISCO, as a proportion of total workers employed.	0.1224	0.2668	0	1
Unknown-Skilled	Workers with unknown-skilled occupation according to the definition, as a proportion of total workers employed.	0	0	0	0
Observations			84,829		

Notes: Summary statistics are constructed for all manufacturing firms excluded from the regression analysis covering the years 2001 to 2011. The industrial sectors belonging to firm-year observations are as follows: Manufacture of food products (5226); Manufacture of beverages (274); Manufacture of tobacco products (2); Manufacture of textiles (2569); Manufacture of wearing apparel (2546); Manufacture of leather and related products (498); Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials (3172); Manufacture of paper and paper products (565); Printing and reproduction of recorded media (7582); Manufacture of coke and refined petroleum products (15); Manufacture of chemicals and chemical products (985); Manufacture of basic pharmaceutical products and pharmaceutical preparations (195); Manufacture of rubber and plastic products (2751); Manufacture of other non-metallic mineral products (3474); Manufacture of basic metals (752); Manufacture of fabricated metal products, except machinery and equipment (17705); Manufacture of computer, electronic and optical products (2334); Manufacture of electrical equipment (1882); Manufacture of machinery and equipment n.e.c. (7264); Manufacture of motor vehicles, trailers and semi-trailers (648); Manufacture of other transport equipment (476); Manufacture of furniture (1144); Other manufacturing (7346); Repair and installation of machinery and equipment (15424). The number of firm-year observations in each industry are shown in parenthesis.

Table 3: Summary Statistics and Data Description for Firms with at Least 10 Employees on Average Covering the Years 2001 to 2011

		All Firms				Danish Firms				Non-Danish Firms				*OECD*+ Firms			
Variable	Description	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.
ln(TFP) (WLP Baseline)	The log of firm-level total factor productivity (TFP) from a Cobb-Douglas production function estimated using the Wooldridge (2009) method of the Levinsohn and Petrin (2003) approach (WLP estimator).	3.4727	0.3692	-0.5532	10.1706	3.4091	0.3408	1.4868	9.0576	3.5097	0.3799	-0.5532	10.1706	3.5404	0.3872	-0.5532	10.1706
ln(TFP) (WOP Estimator)	The log of firm-level total factor productivity (TFP) from a Cobb-Douglas production function estimated using the Wooldridge (2009) method of the Olley and Pakes (1996) approach (WOP estimator).	3.2233	0.3620	-0.7797	10.1063	3.1829	0.3383	1.3507	9.0148	3.2469	0.3731	-0.7797	10.1063	3.2704	0.3817	-0.7797	10.1063
ln(TFP) (OLS Firm FE)	The log of firm-level total factor productivity (TFP) from a Cobb-Douglas production function estimated by OLS with firm fixed effects.	4.4175	0.4315	0.1326	9.8848	4.2705	0.3790	1.4827	8.4911	4.5031	0.4372	0.1326	9.8848	4.5586	0.4381	0.1326	9.8848
ln(TFP) (OLS Firm Time FE)	The log of firm-level total factor productivity (TFP) from a Cobb-Douglas production function estimated by OLS with time-varying firm fixed effects.	5.2160	0.5312	0.8820	10.3567	4.9895	0.4304	1.6259	8.7167	5.3478	0.5397	0.8820	10.3567	5.4279	0.5413	0.8820	10.3567
ln(TFP) (LP Estimator)	The log of firm-level total factor productivity (TFP) from a Cobb-Douglas production function estimated by the semi-parametric approach of Levinsohn and Petrin (2003) (LP estimator).	6.5496	0.7030	1.9331	11.2091	6.2241	0.5479	1.9331	9.3308	6.7390	0.7139	2.0434	11.2091	6.8512	0.7160	2.0434	11.2091
ln(TFP) (Translog Firm Time FE)	The log of firm-level total factor productivity (TFP) from a second-order Translog production function estimated by OLS with time-varying firm fixed effects.	11.2753	3.1112	0.8869	33.2431	9.6161	1.6550	1.6834	20.4747	12.2413	3.3443	0.8869	33.2431	12.7894	3.5015	0.8869	33.2431
ln(*Gross Production*)	The log of firm-level gross production as total sales of goods and services (in 1,000 DKK).	10.2282	1.3845	2.5649	17.5156	9.4837	0.9234	2.5649	14.6068	10.6617	1.4233	5.1648	17.5156	10.9015	1.4488	5.1648	17.5156
ln(*Labor*)	The log of firm-level workforce (head counts).	3.3806	1.0627	0	9.4460	2.7530	0.6675	0	5.5910	3.7459	1.0792	0	9.446	3.9263	1.1223	0	9.446
ln(*Materials*)	The log of firm-level intermediate goods (purchase of goods, supplementary materials, and packaging, excluding energy) (in 1,000 DKK).	9.2289	1.5719	0	17.0328	8.4593	1.1462	0	13.9332	9.6769	1.6122	0	17.0328	9.9188	1.6404	0	17.0328
ln(*Capital*)	The log of firm-level fixed assets (in 1,000 DKK).	8.7377	1.7565	0	17.3656	7.9871	1.3307	0	13.5065	9.1747	1.8253	0	17.3656	9.4293	1.8696	0	17.3656
Share Foreigner	Foreign workers, as a proportion of total workers employed.	0.0671	0.0993	0	1	0	0	0	0	0.1062	0.1071	0.0027	1	0.1120	0.1126	0.0036	1
Share *OECD*+	Share of foreign workers from OECD countries and selected non-member countries (China, Romania, Russia, Singapore, and South Africa), as a proportion of total workers employed.	0.0324	0.0636	0	1	0	0	0	0	0.0512	0.0738	0	1	0.0675	0.0779	0.0024	1
Share *Non-OECD*+	Share of foreign workers from *Non-OECD*+ countries, as a proportion of total workers employed.	0.0348	0.0657	0	1	0	0	0	0	0.0550	0.0756	0	1	0.0445	0.0693	0	0.8
Workforce Ethnic Diversity	Firm-level workforce ethnic diversity measure.	0.1130	0.1390	0	0.8556	0	0	0	0	0.1788	0.1371	0	0.8556	0.1876	0.1437	0	0.8556
ln(*Average Firm Tenure*)	The log of average firm tenure (in years) across all employees.	1.5450	0.4753	0	2.8332	1.5362	0.5094	0	2.8332	1.5501	0.4542	0	2.8332	1.5608	0.4484	0	2.8134
Share Males	Men, as a proportion of total workers employed.	0.6955	0.2400	0	1	0.7022	0.2623	0	1	0.6916	0.2259	0	1	0.6946	0.2182	0	1
Share Managers	Managers, according to Statistics Denmark's definitions based on ISCO, as a proportion of total workers employed.	0.0574	0.0716	0	1	0.0610	0.0867	0	1	0.0554	0.0610	0	1	0.0551	0.0599	0	1
Exporter	Dummy variable that takes value 1 if the firm exports and zero otherwise.	0.6893	0.4628	0	1	0.5565	0.4968	0	1	0.7667	0.4229	0	1	0.8020	0.3985	0	1
Age15_29	Workers aged between 15 and 29, as a proportion of total workers employed.	0.2420	0.2034	0	1	0.2737	0.2266	0	1	0.2235	0.1861	0	1	0.2086	0.1729	0	1
Age30_40	Workers aged between 30 and 40, as a proportion of total workers employed.	0.2737	0.1315	0	1	0.2593	0.1543	0	1	0.2821	0.1153	0	1	0.2870	0.1109	0	1
Age41_50	Workers aged between 41 and 50, as a proportion of total workers employed.	0.2523	0.1318	0	1	0.2338	0.1534	0	1	0.2630	0.1161	0	1	0.2692	0.1100	0	1
Age51_65	Workers aged between 51 and 65, as a proportion of total workers employed.	0.2320	0.1463	0	1	0.2333	0.1752	0	1	0.2313	0.1264	0	1	0.2352	0.1223	0	1
Basic Education	Workers with basic education, as a proportion of total workers employed.	0.3135	0.1731	0	1	0.3189	0.1971	0	1	0.3103	0.1574	0	1	0.3026	0.1493	0	1
Secondary Education	Workers with secondary education, as a proportion of total workers employed.	0.5625	0.1741	0	1	0.5903	0.2018	0	1	0.5462	0.1535	0	1	0.5436	0.1477	0	1
Tertiary Education	Workers with tertiary education, as a proportion of total workers employed.	0.1072	0.1158	0	1	0.0837	0.1190	0	1	0.1209	0.1117	0	1	0.1286	0.1141	0	1
Unclassified Education	Workers with unclassified education, as a proportion of total workers employed.	0.0016	0.0117	0	1	0.0016	0.0153	0	1	0.0016	0.0089	0	0.3333	0.0018	0.0092	0	0.3333
Unknown Education	Workers with unknown education, as a proportion of total workers employed.	0.0152	0.0401	0	1	0.0055	0.0222	0	1	0.0209	0.0467	0	1	0.0235	0.0506	0	1
Low-Skilled	Workers with low-skilled occupation according to the definition of ISCO, as a proportion of total workers employed.	0.1720	0.2074	0	1	0.1718	0.2153	0	1	0.1720	0.2027	0	1	0.1681	0.1982	0	1
Medium-skilled	Workers with medium-skilled occupation according to the definition of ISCO, as a proportion of total workers employed.	0.5654	0.2326	0	1	0.5724	0.2391	0	1	0.5613	0.2287	0	1	0.5580	0.2289	0	1
High-Skilled	Workers with high-skilled occupation according to the definition of ISCO, as a proportion of total workers employed.	0.1280	0.1495	0	1	0.1031	0.1457	0	1	0.1425	0.1498	0	1	0.1547	0.1554	0	1
Military-Skilled	Workers with military-skilled occupation according to the definition of ISCO, as a proportion of total workers employed.	0.0772	0.1707	0	1	0.0917	0.1860	0	1	0.0688	0.1605	0	1	0.0641	0.1551	0	1
Unknown-Skilled	Workers with unknown-skilled occupation according to the definition, as a proportion of total workers employed.	0	0.0003	0	0.0625	0	0.0005	0	0.0625	0	0.0002	0	0.0313	0	0.0002	0	0.0313
Observations		49,673				18,278				31,395				23,836			

Notes: Summary statistics are constructed for all manufacturing firms employed in the regression analysis covering the years 2001 to 2011. The industrial sectors utilized in the empirical analysis are as follows: Manufacture of food products (9023); Manufacture of beverages (238); Manufacture of tobacco products (67); Manufacture of textiles (983); Manufacture of wearing apparel (672); Manufacture of leather and related products (70); Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials (2058); Manufacture of paper and paper products (901); Printing and reproduction of recorded media (2431); Manufacture of coke and refined petroleum products (24); Manufacture of chemicals and chemical products (1084); Manufacture of basic pharmaceutical products and pharmaceutical preparations (309); Manufacture of rubber and plastic products (2856); Manufacture of other non-metallic mineral products (1747); Manufacture of basic metals (657); Manufacture of fabricated metal products, except machinery and equipment (8770); Manufacture of computer, electronic and optical products (2101); Manufacture of electrical equipment (1540); Manufacture of machinery and equipment n.e.c. (6874); Manufacture of motor vehicles, trailers and semi-trailers (748); Manufacture of other transport equipment (417); Manufacture of furniture (2459); Other manufacturing (1298); Repair and installation of machinery and equipment (2346). The number of firm-year observations in each industry are shown in parenthesis.

Table 4: Summary Statistics and Data Description for Workers

		All Workers				Danish Workers				Non-Danish Workers				$OECD^{+}$ Workers			
Variable	Description	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.
Age	Age in years.	40.7873	11.6975	15	65	40.9705	11.7568	15	65	38.4911	10.664	15	65	39.7422	10.9826	15	65
Male Indicator	Indicator that takes value 1 for male workers, zero otherwise.	0.6876	0.4635	0	1	0.6881	0.4633	0	1	0.6813	0.4660	0	1	0.6827	0.4654	0	1
Tenure	Firm tenure in years between 1995 and 2011.	5.4034	3.9605	1	17	5.4994	3.9865	1	17	4.1997	3.3954	1	17	4.2232	3.4560	1	17
Foreigner Indicator	Indicator that takes value 1 for non-Danish workers, zero otherwise.	0.0739	0.2616	0	1	0	0	0	0	1	0	1	1	1	0	1	1
$OECD^{+}$ Indicator	Indicator that takes value 1 for immigrants from OECD countries and selected non-member countries (China, Romania, Russia, Singapore, and South Africa).	0.0357	0.1855	0	1	0	0	0	0	0.4827	0.4997	0	1	1	0	1	1
Basic Education Indicator	Indicator that takes value 1 for workers with basic education, zero otherwise.	0.2899	0.4537	0	1	0.3024	0.4593	0	1	0.1331	0.3396	0	1	0.1187	0.3234	0	1
Secondary Education Indicator	Indicator that takes value 1 for workers with secondary education, zero otherwise.	0.5352	0.4988	0	1	0.5331	0.4989	0	1	0.5608	0.4963	0	1	0.4926	0.4999	0	1
Tertiary Education Indicator	Indicator that takes value 1 for workers with tertiary education, zero otherwise.	0.1569	0.3637	0	1	0.1562	0.3631	0	1	0.1657	0.3719	0	1	0.1961	0.3970	0	1
Unclassified Education Indicator	Indicator that takes value 1 for workers with unclassified education, zero otherwise.	0.0014	0.0371	0	1	0.0014	0.0373	0	1	0.0012	0.0341	0	1	0.0019	0.0439	0	1
Unknown Education Indicator	Indicator that takes value 1 for workers with unknown education, zero otherwise.	0.0167	0.1281	0	1	0.0069	0.0828	0	1	0.1392	0.3462	0	1	0.1908	0.3929	0	1
Low-Skilled Indicator	Indicator that takes value 1 for workers with low-skilled occupational position, zero otherwise.	0.1365	0.3433	0	1	0.1317	0.3382	0	1	0.1962	0.3971	0	1	0.1845	0.3879	0	1
Medium-skilled Indicator	Indicator that takes value 1 for workers with medium-skilled occupational position, zero otherwise.	0.5691	0.4952	0	1	0.5682	0.4953	0	1	0.5803	0.4935	0	1	0.5195	0.4996	0	1
High-Skilled Indicator	Indicator that takes value 1 for workers with high-skilled occupational position, zero otherwise.	0.2078	0.4057	0	1	0.2121	0.4088	0	1	0.1539	0.3609	0	1	0.2181	0.4130	0	1
Managers Indicator	Indicator that takes value 1 for workers with manager occupational position, zero otherwise.	0.0427	0.2021	0	1	0.0447	0.2065	0	1	0.0180	0.1328	0	1	0.0310	0.1734	0	1
Military-Skilled Indicator	Indicator that takes value 1 for workers with unknown occupational position, zero otherwise.	0.0439	0.2049	0	1	0.0433	0.2035	0	1	0.0516	0.2212	0	1	0.0467	0.2111	0	1
Unknown-Skilled Indicator	Indicator that takes value 1 for workers with unknown occupational position, zero otherwise.	0	0.0018	0	1	0	0.0006	0	1	0	0.0062	0	1	0	0.0049	0	1
Observations			3,517,458				3,257,529				259,929				125,475		

Notes: Summary statistics are calculated for all workers employed in the regression analysis covering the years 2001 to 2011.

Table 5: Summary Statistics and Data Description for $OECD^+$ Workers with Unknown Educational Status

Occupational Position	Description	Mean	S.D.	Min.	Max.
Low-Skilled Indicator	Indicator that takes value 1 for workers with low-skilled occupational position, zero otherwise.	0.2459	0.4307	0	1
Medium-skilled Indicator	Indicator that takes value 1 for workers with medium-skilled occupational position, zero otherwise.	0.5411	0.4983	0	1
High-Skilled Indicator	Indicator that takes value 1 for workers with high-skilled occupational position, zero otherwise.	0.1552	0.3621	0	1
Managers Indicator	Indicator that takes value 1 for workers with manager occupational position, zero otherwise.	0.0358	0.1857	0	1
Military-Skilled Indicator	Indicator that takes value 1 for workers with unknown occupational position, zero otherwise.	0.0220	0.1466	0	1
Unknown-Skilled Indicator	Indicator that takes value 1 for workers with unknown occupational position, zero otherwise.	0	0.0065	0	1
Observations			23,940		

Notes: Summary statistics are calculated for all $OECD^+$ workers employed in the regression analysis covering the years 2001 to 2011. The table reports the occupational position of $OECD^+$ workers with unknown educational status.

Table 6: Summary Statistics and Data Description for $OECD^+$ Workers with Unclassified Educational Status

Occupational Position	Description	Mean	S.D.	Min.	Max.
Low-Skilled Indicator	Indicator that takes value 1 for workers with low-skilled occupational position, zero otherwise.	0.0579	0.2339	0	1
Medium-skilled Indicator	Indicator that takes value 1 for workers with medium-skilled occupational position, zero otherwise.	0.1694	0.3759	0	1
High-Skilled Indicator	Indicator that takes value 1 for workers with high-skilled occupational position, zero otherwise.	0.7231	0.4484	0	1
Managers Indicator	Indicator that takes value 1 for workers with manager occupational position, zero otherwise.	0.0207	0.1425	0	1
Military-Skilled Indicator	Indicator that takes value 1 for workers with unknown occupational position, zero otherwise.	0.0289	0.1679	0	1
Unknown-Skilled Indicator	Indicator that takes value 1 for workers with unknown occupational position, zero otherwise.	0	0	0	0
Observations			242		

Notes: Summary statistics are calculated for all $OECD^+$ workers employed in the regression analysis covering the years 2001 to 2011. The table reports the occupational position of $OECD^+$ workers with unclassified educational status.

Table 7: Summary Statistics and Data Description for the Main Firm Variables used in the Regression Analysis

Variable	Description	Mean	S.D.	Min.	Max.
$\ln(TFP)$ (WLP Baseline)	The log of firm-level total factor productivity (TFP) from a Cobb-Douglas production function estimated using the Wooldridge (2009) method of the Levinsohn and Petrin (2003) approach (WLP estimator).	3.4727	0.3692	-0.5532	10.1706
$\ln(TFP)$ (WOP Estimator)	The log of firm-level total factor productivity (TFP) from a Cobb-Douglas production function estimated using the Wooldridge (2009) method of the Olley and Pakes (1996) approach (WOP estimator).	3.2233	0.3620	-0.7797	10.1063
$\ln(TFP)$ (OLS Firm FE)	The log of firm-level total factor productivity (TFP) from a Cobb-Douglas production function estimated by OLS with firm fixed effects.	4.4175	0.4315	0.1326	9.8848
$\ln(TFP)$ (OLS Firm Time FE)	The log of firm-level total factor productivity (TFP) from a Cobb-Douglas production function estimated by OLS with time-varying firm fixed effects.	5.2160	0.5312	0.8820	10.3567
$\ln(TFP)$ (LP Estimator)	The log of firm-level total factor productivity (TFP) from a Cobb-Douglas production function estimated by the semi-parametric approach of Levinsohn and Petrin (2003) (LP estimator).	6.5496	0.7030	1.9331	11.2091
$\ln(TFP)$ (Translog Firm Time FE)	The log of firm-level total factor productivity (TFP) from a second-order Translog production function estimated by OLS with time-varying firm fixed effects.	11.2753	3.1112	0.8869	33.2431
$\ln(Gross\ Production)$	The log of firm-level gross production as total sales of goods and services (in 1,000 DKK).	10.2282	1.3845	2.5649	17.5156
$\ln(Labor)$	The log of firm-level workforce (head counts).	3.3806	1.0627	0	9.446
$\ln(Materials)$	The log of firm-level intermediate goods (purchase of goods, supplementary materials, and packaging, excluding energy) (in 1,000 DKK).	9.2289	1.5719	0	17.0328
$\ln(Capital)$	The log of firm-level fixed assets (in 1,000 DKK).	8.7377	1.7565	0	17.3656
$\ln\left(s_{t-1}^{f,total}\right)$	The log of total foreign R&D capital stock.	28.971	0.1139	28.8038	29.1531
$(Share\ Foreigner)_{t-1}$	Share of foreign workers, as a proportion of total workers employed.	0.0649	0.0960	0	1
$\left[(Share\ Foreigner) \times \ln\left(s^{f,total}\right)\right]_{t-1}$	Interaction term between the Foreigner share and the log of total foreign R&D capital stock.	1.8807	2.7825	0	29.1531
$(Share\ OECD^{+})_{t-1}$	Share of foreign workers from OECD countries and selected non-member countries (China, Romania, Russia, Singapore, and South Africa), as a proportion of total workers employed.	0.0311	0.0611	0	1
$\left[(Share\ OECD^{+}) \times \ln\left(s^{f,total}\right)\right]_{t-1}$	Interaction term between the $OECD^{+}$ share and the log of total foreign R&D capital stock.	0.9016	1.7709	0	29.1531
$(Share\ Non\text{-}OECD^{+})_{t-1}$	Share of foreign workers from $Non\text{-}OECD^{+}$ countries, as a proportion of total workers employed.	0.0338	0.0637	0	1
$\left[(Share\ Non\text{-}OECD^{+}) \times \ln\left(s^{f,total}\right)\right]_{t-1}$	Interaction term between the $Non\text{-}OECD^{+}$ share and the log of total foreign R&D capital stock.	0.9791	1.8476	0	28.8038
$\ln\left(s_{t-1}^{f,ew}\right)$	Firm-level ethnicity-weighted R&D capital stock based on foreign workers from $OECD^{+}$ countries.	7.6957	8.3853	0	24.6057
$\ln\left(s_{t-1}^{f,eweduc,basic\ education}\right)$	Firm-level ethnicity-weighted R&D capital stock based on foreign workers with basic education from $OECD^{+}$ countries.	1.8514	4.8943	0	21.7771
$\ln\left(s_{t-1}^{f,eweduc,secondary\ education}\right)$	Firm-level ethnicity-weighted R&D capital stock based on foreign workers with secondary education from $OECD^{+}$ countries.	5.8388	7.9344	0	23.1095
$\ln\left(s_{t-1}^{f,eweduc,tertiary\ education}\right)$	Firm-level ethnicity-weighted R&D capital stock based on foreign workers with tertiary education from $OECD^{+}$ countries.	2.6445	6.0865	0	23.8503
$\ln\left(s_{t-1}^{f,eweduc,unclassified\ education}\right)$	Firm-level ethnicity-weighted R&D capital stock based on foreign workers with unclassified education from $OECD^{+}$ countries.	0.0735	1.1024	0	20.7751
$\ln\left(s_{t-1}^{f,eweduc,unknown\ education}\right)$	Firm-level ethnicity-weighted R&D capital stock based on foreign workers with unknown education from $OECD^{+}$ countries.	1.8727	5.1194	0	23.4126
$\ln\left(s_{t-1}^{f,ewoccu,low-skilled}\right)$	Firm-level ethnicity-weighted R&D capital stock based on foreign workers with low-skilled occupational position.	2.4317	5.7182	0	23.3418
$\ln\left(s_{t-1}^{f,ewoccu,medium-skilled}\right)$	Firm-level ethnicity-weighted R&D capital stock based on foreign workers with medium-skilled occupational position.	5.3150	7.6794	0	23.3223
$\ln\left(s_{t-1}^{f,ewoccu,high-skilled}\right)$	Firm-level ethnicity-weighted R&D capital stock based on foreign workers with high-skilled occupational position.	2.2139	5.7270	0	24.1781
$\ln\left(s_{t-1}^{f,ewoccu,managers}\right)$	Firm-level ethnicity-weighted R&D capital stock based on foreign workers with manager occupational position.	0.7484	3.4603	0	22.6344
$\ln\left(s_{t-1}^{f,ewoccu,military-skilled}\right)$	Firm-level ethnicity-weighted R&D capital stock based on foreign workers with military-skilled occupational position.	0.8285	3.5387	0	22.2222
$\ln\left(s_{t-1}^{f,ewoccu,unknown-skilled}\right)$	Firm-level ethnicity-weighted R&D capital stock based on foreign workers with unknown-skilled occupational position.	0.0006	0.1052	0	20.2714
Workforce Ethnic Diversity	Firm-level workforce ethnic diversity measure.	0.1130	0.1390	0	0.8556
Share Foreigner	Foreign workers, as a proportion of total workers employed.	0.0671	0.0993	0	1
$\ln(Average\ Firm\ Tenure)$	The log of average firm tenure (in years) across all employees.	1.5450	0.4753	0	2.8332
Share Males	Men, as a proportion of total workers employed.	0.6955	0.2400	0	1
Share Managers	Managers, according to Statistics Denmark's definitions based on ISCO, as a proportion of total workers employed.	0.0574	0.0716	0	1
Exporter	Dummy variable that takes value 1 if the firm exports and zero otherwise.	0.6893	0.4628	0	1

Notes: *continued on next page*

Table 7: Summary Statistics and Data Description for the Main Firm Variables used in the Regression Analysis

Variable	Description	Mean	S.D.	Min.	Max.
Age15_29	Workers aged between 15 and 29, as a proportion of total workers employed.	0.2420	0.2034	0	1
Age30_40	Workers aged between 30 and 40, as a proportion of total workers employed.	0.2737	0.1315	0	1
Age41_50	Workers aged between 41 and 50, as a proportion of total workers employed.	0.2523	0.1318	0	1
Age51_65	Workers aged between 51 and 65, as a proportion of total workers employed.	0.2320	0.1463	0	1
Basic Education	Workers with basic education, as a proportion of total workers employed.	0.3135	0.1731	0	1
Secondary Education	Workers with secondary education, as a proportion of total workers employed.	0.5625	0.1741	0	1
Tertiary Education	Workers with tertiary education, as a proportion of total workers employed.	0.1072	0.1158	0	1
Unclassified Education	Workers with unclassified education, as a proportion of total workers employed.	0.0016	0.0117	0	1
Unknown Education	Workers with unknown education, as a proportion of total workers employed.	0.0152	0.0401	0	1
Low-Skilled	Workers with low-skilled occupation according to the definition of ISCO, as a proportion of total workers employed.	0.1720	0.2074	0	1
Medium-skilled	Workers with medium-skilled occupation according to the definition of ISCO, as a proportion of total workers employed.	0.5654	0.2326	0	1
High-Skilled	Workers with high-skilled occupation according to the definition of ISCO, as a proportion of total workers employed.	0.1280	0.1495	0	1
Military-Skilled	Workers with military-skilled occupation according to the definition of ISCO, as a proportion of total workers employed.	0.0772	0.1707	0	1
Unknown-Skilled	Workers with unknown-skilled occupation according to the definition, as a proportion of total workers employed.	0	0.0003	0	0.0625
Observations			49,673		

Notes: Summary statistics are constructed for all manufacturing firms employed in the regression analysis covering the years 2001 to 2011. The industrial sectors utilized in the empirical analysis are as follows: Manufacture of food products (9023); Manufacture of beverages (238); Manufacture of tobacco products (67); Manufacture of textiles (983); Manufacture of wearing apparel (672); Manufacture of leather and related products (70); Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials (2058); Manufacture of paper and paper products (901); Printing and reproduction of recorded media (2431); Manufacture of coke and refined petroleum products (24); Manufacture of chemicals and chemical products (1084); Manufacture of basic pharmaceutical products and pharmaceutical preparations (309); Manufacture of rubber and plastic products (2856); Manufacture of other non-metallic mineral products (1747); Manufacture of basic metals (657); Manufacture of fabricated metal products, except machinery and equipment (8770); Manufacture of computer, electronic and optical products (2101); Manufacture of electrical equipment (1540); Manufacture of machinery and equipment n.e.c. (6874); Manufacture of motor vehicles, trailers and semi-trailers (748); Manufacture of other transport equipment (417); Manufacture of furniture (2459); Other manufacturing (1298); Repair and installation of machinery and equipment (2346). The number of firm-year observations in each industry are shown in parenthesis.

Table 8: Correlation Matrix for the Main Firm Variables used in the Regression Analysis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)
(1) ln(TFP) (WLP Baseline)	1.0000
(2) ln(TFP) (WOP Estimator)	0.9929	1.0000
(3) ln(TFP) (OLS Firm FE)	0.8922	0.8383	1.0000
(4) ln(TFP) (OLS Firm Time FE)	0.7906	0.7146	0.9749	1.0000
(5) ln(TFP) (LP Estimator)	0.6585	0.5659	0.9104	0.9779	1.0000
(6) ln(TFP) (Translog Firm Time FE)	0.3454	0.2352	0.6398	0.7890	0.8742	1.0000
(7) ln($Gross\ Production$)	0.4737	0.3661	0.7720	0.8939	0.9577	0.9706	1.0000
(8) ln($Labor$)	0.2601	0.1615	0.5211	0.6685	0.7297	0.9195	0.8730	1.0000
(9) ln($Materials$)	0.1906	0.0737	0.5809	0.7412	0.8625	0.9220	0.9377	0.7831	1.0000
(10) ln($Capital$)	0.3173	0.2289	0.4499	0.5879	0.6776	0.8481	0.7897	0.7333	0.7165	1.0000
(11) $\ln\left(s_{t-1}^{f,total}\right)$	0.1788	0.1785	0.1689	0.1430	0.1272	0.0291	0.0651	-0.0555	0.0466	0.0318	1.0000
(12) $(Share\ Foreigner)_{t-1}$	0.0246	0.0175	0.0463	0.0545	0.0611	0.0547	0.0619	0.0440	0.0639	0.0505	0.0966	1.0000
(13) $\left[(Share\ Foreigner) \times \ln\left(s^{f,total}\right)\right]_{t-1}$	0.0251	0.0180	0.0468	0.0549	0.0615	0.0548	0.0621	0.0438	0.0640	0.0505	0.0992	1.0000	1.0000
(14) $(Share\ OECD^{+})_{t-1}$	0.0475	0.0421	0.0614	0.0636	0.0659	0.0466	0.0572	0.0260	0.0549	0.0448	0.0877	0.7572	0.7574	1.0000
(15) $\left[(Share\ OECD^{+}) \times \ln\left(s^{f,total}\right)\right]_{t-1}$	0.0479	0.0425	0.0618	0.0639	0.0662	0.0466	0.0574	0.0259	0.0550	0.0449	0.0897	0.7572	0.7575	1.0000	1.0000
(16) $(Share\ Non\text{-}OECD^{+})_{t-1}$	-0.0085	-0.0141	0.0108	0.0211	0.0288	0.0378	0.0383	0.0413	0.0436	0.0330	0.0614	0.7800	0.7798	0.1819	0.1820	1.0000
(17) $\left[(Share\ Non\text{-}OECD^{+}) \times \ln\left(s^{f,total}\right)\right]_{t-1}$	-0.0081	-0.0137	0.0112	0.0214	0.0291	0.0379	0.0385	0.0412	0.0437	0.0331	0.0634	0.7802	0.7800	0.1822	0.1823	1.0000	1.0000
(18) $\ln\left(s_{t-1}^{f,ew}\right)$	0.2203	0.1651	0.3629	0.4336	0.4631	0.5173	0.5128	0.5185	0.4603	0.4236	0.0541	0.4179	0.4179	0.5098	0.5096	0.1407	0.1409	1.0000
(19) $\ln\left(s_{t-1}^{f,eweduc,basic\ education}\right)$	0.1074	0.0705	0.1943	0.2509	0.2732	0.3763	0.3320	0.3887	0.2891	0.3033	-0.0000	0.2779	0.2776	0.3046	0.3043	0.1265	0.1264	0.4262	1.0000
(20) $\ln\left(s_{t-1}^{f,eweduc,secondary\ education}\right)$	0.2134	0.1581	0.3549	0.4273	0.4580	0.5241	0.5112	0.5223	0.4588	0.4288	0.0004	0.3405	0.3402	0.4130	0.4126	0.1169	0.1168	0.8279	0.3023	1.0000
(21) $\ln\left(s_{t-1}^{f,eweduc,tertiary\ education}\right)$	0.2063	0.1547	0.3353	0.4022	0.4308	0.5078	0.4789	0.4841	0.4288	0.4086	0.0277	0.2115	0.2115	0.2554	0.2553	0.0738	0.0739	0.5283	0.2812	0.3579	1.0000
(22) $\ln\left(s_{t-1}^{f,eweduc,unclassified\ education}\right)$	0.0527	0.0402	0.0801	0.0975	0.1034	0.1396	0.1194	0.1318	0.1014	0.1091	-0.0331	0.0232	0.0231	0.0377	0.0375	-0.0011	-0.0012	0.0912	0.0988	0.0752	0.1007	1.0000
(23) $\ln\left(s_{t-1}^{f,eweduc,unknown\ education}\right)$	0.1766	0.1366	0.2731	0.3233	0.3453	0.3991	0.3773	0.3667	0.3372	0.3300	0.1976	0.2988	0.2997	0.3507	0.3514	0.1139	0.1145	0.4323	0.2659	0.2878	0.3065	0.0739	1.0000
(24) $\ln\left(s_{t-1}^{f,ewoccu,low-skilled}\right)$	0.1246	0.0895	0.2096	0.2584	0.2795	0.3468	0.3204	0.3386	0.2856	0.2853	0.0822	0.3197	0.3199	0.3582	0.3583	0.1381	0.1383	0.4831	0.3893	0.4258	0.3347	0.0859	0.3824	1.0000
(25) $\ln\left(s_{t-1}^{f,ewoccu,medium-skilled}\right)$	0.1895	0.1368	0.3257	0.3965	0.4264	0.4987	0.4823	0.5049	0.4330	0.4030	0.0196	0.3164	0.3163	0.3872	0.3870	0.1054	0.1055	0.7699	0.4018	0.7235	0.4137	0.0783	0.3918	0.2383	1.0000
(26) $\ln\left(s_{t-1}^{f,ewoccu,high-skilled}\right)$	0.2232	0.1707	0.3531	0.4197	0.4476	0.5229	0.4931	0.4919	0.4396	0.4207	0.0494	0.1100	0.1102	0.1550	0.1550	0.0172	0.0174	0.4805	0.2772	0.4295	0.5867	0.1512	0.3240	0.2312	0.2928	1.0000
(27) $\ln\left(s_{t-1}^{f,ewoccu,managers}\right)$	0.1435	0.1129	0.2108	0.2500	0.2647	0.3206	0.2940	0.2993	0.2541	0.2671	0.0209	0.0961	0.0961	0.1178	0.1177	0.0318	0.0319	0.2797	0.2061	0.2617	0.3476	0.0953	0.2496	0.1557	0.1894	0.2809	1.0000
(28) $\ln\left(s_{t-1}^{f,ewoccu,military-skilled}\right)$	0.0488	0.0329	0.0873	0.1110	0.1204	0.1588	0.1438	0.1644	0.1261	0.1283	-0.0406	0.1489	0.1485	0.1706	0.1701	0.0608	0.0606	0.2616	0.1753	0.2345	0.1745	0.0507	0.1035	0.0325	0.0776	0.1053	0.0610	1.0000
(29) $\ln\left(s_{t-1}^{f,ewoccu,unknown-skilled}\right)$	0.0184	0.0159	0.0219	0.0248	0.0246	0.0349	0.0274	0.0312	0.0203	0.0259	0.0029	0.0022	0.0022	0.0024	0.0024	0.0009	0.0009	0.0117	0.0232	0.0129	0.0203	-0.0004	0.0229	0.0203	0.0132	0.0222	0.0340	-0.0014	1.0000
(30) Workforce Ethnic Diversity	0.0269	0.0131	0.0693	0.0893	0.1004	0.1112	0.1161	0.1204	0.1130	0.0897	0.0921	0.8281	0.8281	0.5804	0.5804	0.6906	0.6907	0.4251	0.2733	0.3553	0.2226	0.0263	0.2870	0.3059	0.3274	0.1365	0.1071	0.1523	0.0035	1.0000
(31) Share Foreigner	0.0188	0.0104	0.0452	0.0564	0.0645	0.0634	0.0696	0.0587	0.0719	0.0554	0.0854	0.8824	0.8824	0.6669	0.6670	0.6895	0.6896	0.3589	0.2426	0.2994	0.1899	0.0198	0.2687	0.2805	0.2726	0.0956	0.0894	0.1377	0.0022	0.9368	1.0000
(32) ln($Average\ Firm\ Tenure$)	0.2639	0.2494	0.2814	0.2714	0.2631	0.1668	0.2070	0.0666	0.1709	0.1712	0.3050	-0.0332	-0.0325	-0.0223	-0.0217	-0.0287	-0.0281	0.0872	0.0056	0.0936	0.0601	0.0165	0.0706	0.0138	0.0926	0.0966	0.0533	-0.0266	0.0034	-0.0538	-0.0605	1.0000
(33) Share Males	0.2258	0.2110	0.2684	0.2578	0.2539	0.1255	0.1903	0.0328	0.1791	0.1092	0.0145	-0.0756	-0.0756	-0.0311	-0.0310	-0.0841	-0.0841	0.0023	-0.0939	0.0269	-0.0118	-0.0057	-0.0012	-0.0676	0.0321	-0.0007	-0.0139	-0.0379	-0.0058	-0.0860	-0.0774	0.2059	1.0000
(34) Share Managers	0.0833	0.0871	0.0696	0.0485	0.0425	-0.0393	-0.0058	-0.1090	0.0010	-0.0095	0.1309	-0.0053	-0.0050	0.0145	0.0148	-0.0220	-0.0217	-0.0086	-0.0576	-0.0247	-0.0059	-0.0182	-0.0071	-0.0427	-0.0294	0.0011	0.0750	-0.0637	-0.0038	-0.0252	-0.0228	0.1794	0.0700	1.0000
(35) Exporter	0.2325	0.1857	0.3715	0.4162	0.4463	0.3879	0.4372	0.3137	0.4282	0.3274	0.0165	0.0753	0.0752	0.0694	0.0693	0.0468	0.0468	0.2489	0.0847	0.2386	0.1945	0.0300	0.1302	0.1063	0.2116	0.1987	0.1143	0.0454	0.0041	0.0967	0.0702	0.2294	0.1604	0.1124	1.0000

Notes: The correlation matrix is constructed for all manufacturing firms in the regression analysis covering the years 2001 to 2011.

C Regression Tables

Table 9: Production Function Estimates for Manufacturing Firms

	(1) WLP Baseline	(2) WOP Estimator	(3) LP Estimator	(4) OLS Firm FE	(5) OLS Firm Time FE	(6) Translog Firm Time FE
	Dependent Variable: Log of Firm-Level Gross Production					
ln($Labor$)	0.3376***	0.3442***	0.3203***	0.3200***	0.2834***	0.7551***
	(0.0101)	(0.0141)	(0.0059)	(0.0089)	(0.0099)	(0.0775)
ln($Materials$)	0.5700***	0.5926***	0.2119***	0.4127***	0.3495***	0.1413**
	(0.0303)	(0.0118)	(0.0160)	(0.0115)	(0.0112)	(0.0551)
ln($Capital$)	0.0405***	0.0426***	0.0732***	0.1053***	0.0948***	0.2043***
	(0.0061)	(0.0042)	(0.0053)	(0.0040)	(0.0045)	(0.0344)
ln($Labor$) × ln($Capital$)						0.0023
						(0.0078)
ln($Labor$) × ln($Materials$)						-0.1000***
						(0.0143)
ln($Capital$) × ln($Materials$)						-0.0435***
						(0.0056)
ln($Labor$)^2						0.0647***
						(0.0079)
ln($Capital$)^2						0.0164***
						(0.0019)
ln($Materials$)^2						0.0541***
						(0.0053)
Constant	6.2357***	4.0539***	——	4.3893***	5.1838***	4.4714***
	(0.6024)	(0.2581)	——	(0.0769)	(0.0916)	(0.2737)
Controls Firm Productivity Shock						
ln($Capital$)	Yes	Yes	Yes	None	None	None
ln($Materials$)	Yes	No	Yes	None	None	None
ln($Investment$)	No	Yes	No	None	None	None
Excluded Instruments for Endogenous Inputs: ln($Labor$) and ln($Materials$)						
ln($Labor_{t-1}$)	Yes	Yes	Yes	None	None	None
ln($Labor_{t-2}$)	Yes	Yes	No	None	None	None
ln($Materials_{t-1}$)	No	Yes	Yes	None	None	None
ln($Materials_{t-2}$)	Yes	Yes	Yes	None	None	None
ln($Capital_{t-1}$)	No	No	Yes	None	None	None
Observations	42,026	39,241	57,084	57,084	57,084	57,084
R-squared	0.945	0.940	——	0.684	0.566	0.652
Firm Fixed Effects	No	No	No	Yes	No	No
Firm Time Fixed Effects	No	No	No	No	Yes	Yes

Notes: The dependent variable is the log of firm-level gross production. In column (1), a Cobb-Douglas production function is estimated by the Wooldridge (2009) method of the Levinsohn and Petrin (2003) approach using intermediate inputs as the proxy variable for the unobserved firm-specific productivity shock (WLP estimator). In column (2), a Cobb-Douglas production function is estimated by the Wooldridge (2009)) method of the Olley and Pakes (1996) approach using investment as the proxy variable for the unobserved firm-specific productivity shock (WOP estimator). In column (3), a Cobb-Douglas production function is estimated by the Levinsohn and Petrin (2003) semi-parametric approach (LP estimator). In column (4), a Cobb-Douglas production function is estimated by OLS with firm fixed effects. In column (5), a Cobb-Douglas production function is estimated by OLS with time-varying firm fixed effects. In column (6), a second-order Translog production function is estimated by OLS with time-varying firm fixed effects.

Standard errors, reported in parenthesis, for columns (1), (2), (4), (5), and (6) are clustered at the firm-level. In column (3), bootstrapped standard errors using 500 replications are reported in parenthesis.

*: Significant at the 10% level. **: Significant at the 5% level. ***: Significant at the 1% level.

Table 10: Firm-Level TFP and Absorption of Foreign Knowledge

	(1)	(2)	(3)	(4)	(5)
	Dependent Variable: Log of Firm-Level TFP				
$(Share\ OECD^{+})_{t-1}$	-0.0013	-24.7528***			-24.5591***
	(0.0516)	(8.8770)			(8.9728)
$\left[(Share\ OECD^{+}) \times \ln\left(s^{f,total}\right)\right]_{t-1}$		0.8531***			0.8469***
		(0.3056)			(0.3088)
$(Share\ Non\text{-}OECD^{+})_{t-1}$			0.1004**	-1.5779	1.7099
			(0.0500)	(6.3588)	(6.3249)
$\left[(Share\ Non\text{-}OECD^{+}) \times \ln\left(s^{f,total}\right)\right]_{t-1}$				0.0578	-0.0556
				(0.2192)	(0.2181)
Workforce Ethnic Diversity	-0.0094	-0.0044	-0.0244	-0.0240	-0.0208
	(0.0246)	(0.0245)	(0.0255)	(0.0256)	(0.0265)
ln(*Average Firm Tenure*)	0.0790***	0.0782***	0.0785***	0.0785***	0.0777***
	(0.0121)	(0.0121)	(0.0121)	(0.0121)	(0.0121)
Share Males	-0.0112	-0.0123	-0.0109	-0.0109	-0.0121
	(0.0270)	(0.0269)	(0.0270)	(0.0270)	(0.0269)
Share Managers	3.9079***	3.9007***	3.9777***	3.9805***	3.9728***
	(0.7405)	(0.7038)	(0.8135)	(0.8135)	(0.7799)
Exporter	0.0022	0.0025	0.0022	0.0022	0.0023
	(0.0064)	(0.0064)	(0.0064)	(0.0064)	(0.0064)
Constant	-0.5577	-0.5813	-0.6260	-0.6301	-0.6549
	(0.7468)	(0.7103)	(0.8187)	(0.8191)	(0.7860)
Observations	49,673	49,673	49,673	49,673	49,673
Within R-squared	0.145	0.145	0.145	0.145	0.145
Number of Firms	6,997	6,997	6,997	6,997	6,997
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Industry-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Region Fixed Effects	Yes	Yes	Yes	Yes	Yes
Firm Age Controls	Yes	Yes	Yes	Yes	Yes
Firm Education Controls	Yes	Yes	Yes	Yes	Yes
Firm Occupation Controls	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is the log of firm-level total factor productivity (TFP). TFP for manufacturing firms is constructed from Cobb-Douglas production function estimated by the Wooldridge (2009) method of the Levinsohn and Petrin (2003) approach using intermediate inputs as the proxy variable for the unobserved firm-specific productivity shock.

Independent variables: *Share Foreigner* is the share of foreign workers, as a proportion of total workers employed. $\left[(Share\ Foreigner) \times \ln\left(s^{f,total}\right)\right]$ refers to an interaction term between the Foreigner share and the log of total foreign R&D capital stock. $Share\ OECD^{+}$ is the share of foreign workers from OECD countries and selected non-member countries (China, Romania, Russia, Singapore, and South Africa), as a proportion of total workers employed.
$\left[(Share\ OECD^{+}) \times \ln\left(s^{f,total}\right)\right]$ refers to an interaction term between the $OECD^{+}$ share and the log of total foreign R&D capital stock. $Share\ Non\text{-}OECD^{+}$ is the share of foreign workers from $Non\text{-}OECD^{+}$ countries, as a proportion of total workers employed. $\left[(Share\ Non\text{-}OECD^{+}) \times \ln\left(s^{f,total}\right)\right]$ refers to an interaction term between the $Non\text{-}OECD^{+}$ share and the log of total foreign R&D capital stock. *Workforce Ethnic Diversity* is the firm-level workforce ethnic diversity measure. ln(*Average Firm Tenure*) is the log of average firm tenure (in years) across all employees. *Share Males* is the share of men employees, as a proportion of total workers employed. *Share Managers* is the share of managers employed, as a proportion of total workers employed. *Exporter* is a dummy variable that takes value 1 if the firm exports and zero otherwise. *Firm Age Controls* is a full set of shares of employees belonging to each age distribution quartile. *Firm Education Controls* is a full set of shares of employees with basic, secondary, and tertiary education. *Firm Occupation Controls* is a full set of shares of employees belonging to low-skilled, medium-skilled, high-skilled, and military-skilled occupations.
Standard errors, clustered at the firm-level, are reported in parenthesis.
*: Significant at the 10% level. **: Significant at the 5% level. ***: Significant at the 1% level.

Table 11: Firm-Level TFP and Absorption of Foreign Knowledge (Assessing Immigrant's Educational Status)

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: Log of Firm-Level TFP					
$\ln\left(s_{t-1}^{f,ew}\right)$	0.0009***					
	(0.0003)					
$\ln\left(s_{t-1}^{f,eweduc,basic\ education}\right)$		0.0001				0.0001
		(0.0004)				(0.0004)
$\ln\left(s_{t-1}^{f,eweduc,secondary\ education}\right)$			0.0010***			0.0010***
			(0.0003)			(0.0003)
$\ln\left(s_{t-1}^{f,eweduc,tertiary\ education}\right)$				0.0011***		0.0010***
				(0.0004)		(0.0004)
$\ln\left(s_{t-1}^{f,eweduc,unclassified\ education}\right)$					-0.0019	-0.0020
					(0.0013)	(0.0014)
$\ln\left(s_{t-1}^{f,eweduc,unknown\ education}\right)$					0.0006	0.0005
					(0.0004)	(0.0005)
Workforce Ethnic Diversity	-0.2020**	-0.1856**	-0.1988**	-0.1907**	-0.1889**	-0.2079**
	(0.0883)	(0.0883)	(0.0880)	(0.0875)	(0.0885)	(0.0877)
Share Foreigner	0.3036**	0.2969**	0.3005**	0.2985**	0.2991**	0.3043**
	(0.1429)	(0.1429)	(0.1426)	(0.1419)	(0.1432)	(0.1421)
$\ln(Average\ Firm\ Tenure)$	0.0783***	0.0782***	0.0783***	0.0784***	0.0783***	0.0786***
	(0.0121)	(0.0121)	(0.0121)	(0.0121)	(0.0121)	(0.0121)
Share Males	-0.0121	-0.0120	-0.0119	-0.0116	-0.0119	-0.0115
	(0.0269)	(0.0269)	(0.0269)	(0.0269)	(0.0269)	(0.0269)
Share Managers	4.1314***	4.1043***	4.1621***	4.0844***	4.0787***	4.1389***
	(0.9015)	(0.8768)	(0.9306)	(0.8610)	(0.8550)	(0.9085)
Exporter	0.0027	0.0031	0.0028	0.0029	0.0031	0.0026
	(0.0064)	(0.0064)	(0.0064)	(0.0064)	(0.0064)	(0.0064)
Constant	-0.8288	-0.7951	-0.8499	-0.7743	-0.7854	-0.8352
	(0.9082)	(0.8836)	(0.9368)	(0.8681)	(0.8623)	(0.9150)
Observations	49,673	49,673	49,673	49,673	49,673	49,673
Within R-squared	0.146	0.145	0.146	0.146	0.145	0.146
Number of Firms	6,997	6,997	6,997	6,997	6,997	6,997
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Region Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Age Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Education Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Occupation Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is the log of firm-level total factor productivity (TFP). TFP for manufacturing firms is constructed from Cobb-Douglas production function estimated by the Wooldridge (2009) method of the Levinsohn and Petrin (2003) approach using intermediate inputs as the proxy variable for the unobserved firm-specific productivity shock.

Independent variables: $\ln\left(s^{f,ew}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers from $OECD^{+}$ countries. $\ln\left(s^{f,eweduc,basic\ education}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers with basic education from $OECD^{+}$ countries. $\ln\left(s^{f,eweduc,secondary\ education}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers with secondary education from $OECD^{+}$ countries. $\ln\left(s^{f,eweduc,tertiary\ education}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers with tertiary education from $OECD^{+}$ countries. $\ln\left(s^{f,eweduc,unclassified\ education}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers with unclassified education from $OECD^{+}$ countries. $\ln\left(s^{f,eweduc,unknown\ education}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers with unknown education from $OECD^{+}$ countries. *Workforce Ethnic Diversity* is the firm-level workforce ethnic diversity measure. $\ln(Average\ Firm\ Tenure)$ is the log of average firm tenure (in years) across all employees. *Share Males* is the share of men employees, as a proportion of total workers employed. *Share Managers* is the share of managers employed, as a proportion of total workers employed. *Exporter* is a dummy variable that takes value 1 if the firm exports and zero otherwise. *Firm Age Controls* is a full set of shares of employees belonging to each age distribution quartile.

Firm Education Controls is a full set of shares of employees with basic, secondary, and tertiary education. *Firm Occupation Controls* is a full set of shares of employees belonging to low-skilled, medium-skilled, high-skilled, and military-skilled occupations.

Standard errors, clustered at the firm-level, are reported in parenthesis.

*: Significant at the 10% level. **: Significant at the 5% level. ***: Significant at the 1% level.

Table 12: Firm-Level TFP and Absorption of Foreign Knowledge (Further Assessing Immigrant's Education Status)

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: Log of Firm-Level TFP					
$\ln\left(s_{t-1}^{f,ew}\right)$	0.0009***					
	(0.0003)					
$\ln\left(s_{t-1}^{f,eweduc,basic\ education}\right)$		0.0001				0.0000
		(0.0004)				(0.0004)
$\ln\left(s_{t-1}^{f,eweduc,lower-secondary\ education}\right)$			0.0008*			0.0007*
			(0.0004)			(0.0004)
$\ln\left(s_{t-1}^{f,eweduc,upper-secondary\ education}\right)$			0.0012***			0.0011***
			(0.0004)			(0.0004)
$\ln\left(s_{t-1}^{f,eweduc,post-secondary\ education}\right)$			0.0000			-0.0000
			(0.0004)			(0.0004)
$\ln\left(s_{t-1}^{f,eweduc,short-cycle\ tertiary\ education}\right)$				0.0013***		0.0012***
				(0.0004)		(0.0004)
$\ln\left(s_{t-1}^{f,eweduc,bachelor\ education}\right)$				-0.0002		-0.0003
				(0.0005)		(0.0005)
$\ln\left(s_{t-1}^{f,eweduc,master\ education}\right)$				0.0071***		0.0070***
				(0.0020)		(0.0020)
$\ln\left(s_{t-1}^{f,eweduc,doctoral\ education}\right)$				-0.0003		-0.0004
				(0.0015)		(0.0015)
$\ln\left(s_{t-1}^{f,eweduc,unclassified\ education}\right)$					-0.0019	-0.0018
					(0.0013)	(0.0013)
$\ln\left(s_{t-1}^{f,eweduc,unknown\ education}\right)$					0.0006	0.0005
					(0.0004)	(0.0005)
Workforce Ethnic Diversity	-0.2020**	-0.1856**	-0.1991**	-0.1905**	-0.1889**	-0.2065**
	(0.0883)	(0.0883)	(0.0879)	(0.0878)	(0.0885)	(0.0878)
Share Foreigner	0.3036**	0.2969**	0.3004**	0.2975**	0.2991**	0.3027**
	(0.1429)	(0.1429)	(0.1424)	(0.1423)	(0.1432)	(0.1423)
ln(*Average Firm Tenure*)	0.0783***	0.0782***	0.0784***	0.0785***	0.0783***	0.0787***
	(0.0121)	(0.0121)	(0.0121)	(0.0121)	(0.0121)	(0.0122)
Share Males	-0.0121	-0.0120	-0.0119	-0.0128	-0.0119	-0.0128
	(0.0269)	(0.0269)	(0.0269)	(0.0269)	(0.0269)	(0.0269)
Share Managers	4.1314***	4.1043***	4.1500***	4.0860***	4.0787***	4.1203***
	(0.9015)	(0.8768)	(0.9174)	(0.8516)	(0.8550)	(0.8808)
Exporter	0.0027	0.0031	0.0027	0.0029	0.0031	0.0025
	(0.0064)	(0.0064)	(0.0064)	(0.0064)	(0.0064)	(0.0064)
Constant	-0.8288	-0.7951	-0.8338	-0.7734	-0.7854	-0.8089
	(0.9082)	(0.8836)	(0.9235)	(0.8588)	(0.8623)	(0.8873)
Observations	49,673	49,673	49,673	49,673	49,673	49,673
Within R-squared	0.146	0.145	0.146	0.146	0.145	0.147
Number of Firms	6,997	6,997	6,997	6,997	6,997	6,997
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Region Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Age Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Education Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Occupation Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is the log of firm-level total factor productivity (TFP). TFP for manufacturing firms is constructed from Cobb-Douglas production function estimated by the Wooldridge (2009) method of the Levinsohn and Petrin (2003) approach using intermediate inputs as the proxy variable for the unobserved firm-specific productivity shock. **Independent variables**: $\ln\left(s^{f,ew}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers from $OECD^{+}$ countries. $\ln\left(s^{f,eweduc,basic\ education}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers with basic education from $OECD^{+}$ countries. $\ln\left(s^{f,eweduc,lower-secondary\ education}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers with lower-secondary education from $OECD^{+}$ countries. $\ln\left(s^{f,eweduc,upper-secondary\ education}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers with upper-secondary education from $OECD^{+}$ countries. $\ln\left(s^{f,eweduc,post-secondary\ education}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers with post-secondary education from $OECD^{+}$ countries. $\ln\left(s^{f,eweduc,short-cycle\ tertiary\ education}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers with short-cycle tertiary education from $OECD^{+}$ countries. $\ln\left(s^{f,eweduc,bachelor\ education}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers with bachelor education from $OECD^{+}$ countries. $\ln\left(s^{f,eweduc,master\ education}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers with master education from $OECD^{+}$ countries. $\ln\left(s^{f,eweduc,doctoral\ education}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers with doctoral education from $OECD^{+}$ countries. $\ln\left(s^{f,eweduc,unclassified\ education}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers with unclassified education from $OECD^{+}$ countries. $\ln\left(s^{f,eweduc,unknown\ education}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers with unknown education from $OECD^{+}$ countries. *Workforce Ethnic Diversity* is the firm-level workforce ethnic diversity measure. ln(*Average Firm Tenure*) is the log of average firm tenure (in years) across all employees. *Share Males* is the share of men employees, as a proportion of total workers employed. *Share Managers* is the share of managers employed, as a proportion of total workers employed. *Exporter* is a dummy variable that takes value 1 if the firm exports and zero otherwise. *Firm Age Controls* is a full set of shares of employees belonging to each age distribution quartile. *Firm Education Controls* is a full set of shares of employees with basic, secondary, and tertiary education. *Firm Occupation Controls* is a full set of shares of employees belonging to low-skilled, medium-skilled, high-skilled, and military-skilled occupations.
Standard errors, clustered at the firm-level, are reported in parenthesis.
*: Significant at the 10% level. **: Significant at the 5% level. ***: Significant at the 1% level.

Table 13: Firm-Level TFP and Absorption of Foreign Knowledge (Assessing Immigrant's Occupational Position)

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: Log of Firm-Level TFP					
$\ln\left(s_{t-1}^{f,ewoccu,low-skilled}\right)$	0.0006**					0.0007**
	(0.0003)					(0.0003)
$\ln\left(s_{t-1}^{f,ewoccu,medium-skilled}\right)$		0.0001				0.0002
		(0.0003)				(0.0003)
$\ln\left(s_{t-1}^{f,ewoccu,high-skilled}\right)$			0.0014***			0.0015***
			(0.0004)			(0.0004)
$\ln\left(s_{t-1}^{f,ewoccu,managers}\right)$				0.0004		0.0004
				(0.0006)		(0.0006)
$\ln\left(s_{t-1}^{f,ewoccu,military-skilled}\right)$					-0.0002	0.0000
					(0.0005)	(0.0005)
$\ln\left(s_{t-1}^{f,ewoccu,unknown-skilled}\right)$					0.0010	0.0009
					(0.0099)	(0.0099)
Workforce Ethnic Diversity	-0.1902**	-0.1868**	-0.1918**	-0.1856**	-0.1847**	-0.2004**
	(0.0883)	(0.0883)	(0.0884)	(0.0880)	(0.0882)	(0.0883)
Share Foreigner	0.2994**	0.2975**	0.3002**	0.2975**	0.2969**	0.3046**
	(0.1430)	(0.1428)	(0.1431)	(0.1425)	(0.1428)	(0.1428)
ln(*Average Firm Tenure*)	0.0783***	0.0782***	0.0781***	0.0782***	0.0782***	0.0783***
	(0.0121)	(0.0121)	(0.0121)	(0.0121)	(0.0121)	(0.0121)
Share Males	-0.0120	-0.0120	-0.0120	-0.0119	-0.0120	-0.0120
	(0.0269)	(0.0269)	(0.0269)	(0.0269)	(0.0269)	(0.0269)
Share Managers	4.1366***	4.0986***	4.0937***	4.0963***	4.0811***	4.1430***
	(0.9059)	(0.8754)	(0.8692)	(0.8714)	(0.8628)	(0.9147)
Exporter	0.0030	0.0031	0.0030	0.0031	0.0031	0.0028
	(0.0064)	(0.0064)	(0.0064)	(0.0064)	(0.0064)	(0.0064)
Constant	-0.8324	-0.7901	-0.7882	-0.7894	-0.7761	-0.8446
	(0.9126)	(0.8823)	(0.8761)	(0.8783)	(0.8699)	(0.9216)
Observations	49,673	49,673	49,673	49,673	49,673	49,673
Within R-squared	0.145	0.145	0.146	0.145	0.145	0.146
Number of Firms	6,997	6,997	6,997	6,997	6,997	6,997
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Region Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Age Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Education Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Occupation Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is the log of firm-level total factor productivity (TFP). TFP for manufacturing firms is constructed from Cobb-Douglas production function estimated by the Wooldridge (2009) method of the Levinsohn and Petrin (2003) approach using intermediate inputs as the proxy variable for the unobserved firm-specific productivity shock.
Independent variables: $\ln\left(s^{f,ewoccu,low-skilled}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers with low-skilled occupational position. $\ln\left(s^{f,ewoccu,medium-skilled}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers with medium-skilled occupational position. $\ln\left(s^{f,ewoccu,high-skilled}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers with high-skilled occupational position. $\ln\left(s^{f,ewoccu,managers}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers with manager occupational position. $\ln\left(s^{f,ewoccu,military-skilled}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers with military-skilled occupational position. $\ln\left(s^{f,ewoccu,unknown-skilled}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers with unknown-skilled occupational position. *Workforce Ethnic Diversity* is the firm-level workforce ethnic diversity measure. ln(*Average Firm Tenure*) is the log of average firm tenure (in years) across all employees. *Share Males* is the share of men employees, as a proportion of total workers employed. *Share Managers* is the share of managers employed, as a proportion of total workers employed. *Exporter* is a dummy variable that takes value 1 if the firm exports and zero otherwise. *Firm Age Controls* is a full set of shares of employees belonging to each age distribution quartile. *Firm Education Controls* is a full set of shares of employees with basic, secondary, and tertiary education. *Firm Occupation Controls* is a full set of shares of employees belonging to low-skilled, medium-skilled, high-skilled, and military-skilled occupations.
Standard errors, clustered at the firm-level, are reported in parenthesis.
*: Significant at the 10% level. **: Significant at the 5% level. ***: Significant at the 1% level.

Table 14: Firm-Level TFP and Absorption of Foreign Knowledge (Assessing Different Sample Sizes)

	(1) Baseline Sample	(2) Non Exporters	(3) Non Multi-nationals	(4) Excl. Chemicals and Computers	(5) Comparison Group: Danish Firms	(6) Trade Spillovers
	Dependent Variable: Log of Firm-Level TFP					
$\ln\left(s_{t-1}^{f,ew}\right)$	0.0009***	0.0011**	0.0008***	0.0009***	0.0012***	0.0009**
	(0.0003)	(0.0005)	(0.0003)	(0.0003)	(0.0004)	(0.0004)
Workforce Ethnic Diversity	-0.2020**	-0.3064***	-0.2015**	-0.1830**	-0.2209***	-0.4029***
	(0.0883)	(0.0921)	(0.0885)	(0.0913)	(0.0652)	(0.0743)
Share Foreigner	0.3036**	0.4621***	0.3062**	0.2754*	0.3397***	0.5905***
	(0.1429)	(0.1464)	(0.1433)	(0.1487)	(0.1056)	(0.1161)
ln(*Average Firm Tenure*)	0.0783***	0.0836***	0.0781***	0.0807***	0.0760***	0.0623***
	(0.0121)	(0.0168)	(0.0121)	(0.0123)	(0.0144)	(0.0215)
Share Males	-0.0121	-0.0068	-0.0120	-0.0137	-0.0111	0.0228
	(0.0269)	(0.0406)	(0.0270)	(0.0274)	(0.0314)	(0.0480)
Share Managers	4.1314***	-0.0240	4.0934***	4.1461***	3.7647***	3.7360***
	(0.9015)	(0.0886)	(0.9084)	(0.8511)	(0.7622)	(1.3938)
Exporter	0.0027	———	0.0026	0.0031	-0.0017	0.0216
	(0.0064)	———	(0.0064)	(0.0063)	(0.0073)	(0.0158)
$\ln\left(s^{f,trade-spillover,imports}\right)$						-0.0005
						(0.0006)
$\ln\left(s^{f,trade-spillover,exports}\right)$						0.0003
						(0.0006)
Constant	-0.8288	3.3904***	-0.7841	-0.8571	-0.4355	-0.3991
	(0.9082)	(0.1602)	(0.9151)	(0.8588)	(0.7693)	(1.4005)
Observations	49,673	15,432	49,562	48,172	41,489	26,438
Within R-squared	0.146	0.190	0.146	0.143	0.150	0.185
Number of Firms	6,997	3,180	6,977	6,835	6,704	4,194
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Region Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Age Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Education Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Occupation Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is the log of firm-level total factor productivity (TFP). TFP for manufacturing firms is constructed from Cobb-Douglas production function estimated by the Wooldridge (2009) method of the Levinsohn and Petrin (2003) approach using intermediate inputs as the proxy variable for the unobserved firm-specific productivity shock.

Independent variables: $\ln\left(s^{f,ew}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers from $OECD^{+}$ countries. $\ln\left(s^{f,trade-spillover,imports}\right)$ is the log of the bilateral import-share weighted R&D capital stocks of a firm's trading partner countries. $\ln\left(s^{f,trade-spillover,exports}\right)$ is the log of the bilateral export-share weighted R&D capital stocks of a firm's trading partner countries. *Workforce Ethnic Diversity* is the firm-level workforce ethnic diversity measure. ln(*Average Firm Tenure*) is the log of average firm tenure (in years) across all employees. *Share Males* is the share of men employees, as a proportion of total workers employed. *Share Managers* is the share of managers employed, as a proportion of total workers employed. *Exporter* is a dummy variable that takes value 1 if the firm exports and zero otherwise. *Firm Age Controls* is a full set of shares of employees belonging to each age distribution quartile. *Firm Education Controls* is a full set of shares of employees with basic, secondary, and tertiary education. *Firm Occupation Controls* is a full set of shares of employees belonging to low-skilled, medium-skilled, high-skilled, and military-skilled occupations.

Standard errors, clustered at the firm-level, are reported in parenthesis.

*: Significant at the 10% level. **: Significant at the 5% level. ***: Significant at the 1% level.

Table 15: Firm-Level TFP and Absorption of Foreign Knowledge (Assessing Alternative TFP Estimates)

	(1) WLP Baseline	(2) WOP Estimator	(3) LP Estimator	(4) OLS Firm FE	(5) OLS Firm Time FE	(6) Translog Firm Time FE
	Dependent Variable: Log of Firm-Level TFP					
$\ln\left(s_{t-1}^{f,ew}\right)$	0.0009***	0.0006**	0.0035***	0.0017***	0.0025***	0.0164***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0010)
Workforce Ethnic Diversity	-0.2020**	-0.2441***	0.2248*	-0.0291	0.1316	3.0117***
	(0.0883)	(0.0883)	(0.1151)	(0.0940)	(0.0966)	(0.2871)
Share Foreigner	0.3036**	0.3539**	-0.2041	0.1015	-0.0903	-3.5499***
	(0.1429)	(0.1426)	(0.1878)	(0.1529)	(0.1574)	(0.4570)
ln(*Average Firm Tenure*)	0.0783***	0.0898***	-0.0303**	0.0439***	-0.0000	-0.8381***
	(0.0121)	(0.0124)	(0.0122)	(0.0110)	(0.0110)	(0.0509)
Share Males	-0.0121	-0.0067	-0.0743**	-0.0377	-0.0570**	-0.3016**
	(0.0269)	(0.0274)	(0.0354)	(0.0266)	(0.0290)	(0.1501)
Share Managers	4.1314***	4.4320***	0.5467	2.8008***	1.7755***	-15.2755*
	(0.9015)	(1.0032)	(0.9080)	(0.6007)	(0.5421)	(8.4314)
Exporter	0.0027	-0.0033	0.0755***	0.0295***	0.0496***	0.3449***
	(0.0064)	(0.0065)	(0.0079)	(0.0063)	(0.0068)	(0.0271)
Constant	-0.8288	-1.3871	5.9744***	1.5168**	3.3631***	26.6314***
	(0.9082)	(1.0091)	(0.9219)	(0.6133)	(0.5585)	(8.4438)
Observations	49,673	49,673	49,673	49,673	49,673	49,673
Within R-squared	0.146	0.143	0.212	0.165	0.179	0.235
Number of Firms	6,997	6,997	6,997	6,997	6,997	6,997
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Region Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Age Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Education Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Occupation Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is the log of a firm-level total factor productivity (TFP). In column (1), TFP for manufacturing firms is constructed from Cobb-Douglas production function estimated by the Wooldridge (2009) method of the Levinsohn and Petrin (2003) approach using intermediate inputs as the proxy variable for the unobserved firm-specific productivity shock (WLP estimator). In column (2), TFP for manufacturing firms is constructed from Cobb-Douglas production function estimated by the Wooldridge (2009) method of the Levinsohn and Petrin (2003) approach using investment as the proxy variable for the unobserved firm-specific productivity shock (WOP estimator). In column (3), TFP for manufacturing firms is constructed from Cobb-Douglas production function estimated by the of Levinsohn and Petrin (2003) semi-parametric approach (LP estimator). In column (4), TFP for manufacturing firms is constructed from Cobb-Douglas production function estimated by OLS with time-varying firm fixed effects. In column (5), TFP for manufacturing firms is constructed from Cobb-Douglas production function estimated by OLS with firm fixed effects. In column (6), TFP for manufacturing firms is constructed from a second-order Translog production function estimated by OLS with time-varying firm fixed effects.

Independent variables: $\ln\left(s^{f,ew}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers from $OECD^{+}$ countries. *Workforce Ethnic Diversity* is the firm-level workforce ethnic diversity measure. ln(*Average Firm Tenure*) is the log of average firm tenure (in years) across all employees. *Share Males* is the share of men employees, as a proportion of total workers employed. *Share Managers* is the share of managers employed, as a proportion of total workers employed. *Exporter* is a dummy variable that takes value 1 if the firm exports and zero otherwise. *Firm Age Controls* is a full set of shares of employees belonging to each age distribution quartile. *Firm Education Controls* is a full set of shares of employees with basic, secondary, and tertiary education. *Firm Occupation Controls* is a full set of shares of employees belonging to low-skilled, medium-skilled, high-skilled, and military-skilled occupations.

Standard errors, clustered at the firm-level, are reported in parenthesis.

*: Significant at the 10% level. **: Significant at the 5% level. ***: Significant at the 1% level.

D Supplementary Tables

Table 16: Firm-Level TFP and Absorption of Foreign Knowledge (Assessing Immigrant's Education-Duration Status)

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent Variable: Log of Firm-Level TFP					
$\ln\left(s_{t-1}^{f,eweducdur}\right)$	0.0009***					
	(0.0003)					
$\ln\left(s_{t-1}^{f,eweducdur,basic\ education}\right)$		0.0001				0.0001
		(0.0004)				(0.0004)
$\ln\left(s_{t-1}^{f,eweducdur,secondary\ education}\right)$			0.0009***			0.0008***
			(0.0003)			(0.0003)
$\ln\left(s_{t-1}^{f,eweducdur,tertiary\ education}\right)$				0.0009***		0.0009***
				(0.0003)		(0.0003)
$\ln\left(s_{t-1}^{f,eweduc,unclassified\ education}\right)$					-0.0019	-0.0019
					(0.0013)	(0.0014)
$\ln\left(s_{t-1}^{f,eweduc,unknown\ education}\right)$					0.0006	0.0005
					(0.0004)	(0.0005)
Workforce Ethnic Diversity	-0.2032**	-0.1856**	-0.1989**	-0.1907**	-0.1889**	-0.2080**
	(0.0880)	(0.0883)	(0.0881)	(0.0876)	(0.0885)	(0.0877)
Share Foreigner	0.3027**	0.2969**	0.3006**	0.2985**	0.2991**	0.3043**
	(0.1426)	(0.1429)	(0.1426)	(0.1419)	(0.1432)	(0.1421)
ln(*Average Firm Tenure*)	0.0782***	0.0782***	0.0783***	0.0784***	0.0783***	0.0786***
	(0.0121)	(0.0121)	(0.0121)	(0.0121)	(0.0121)	(0.0121)
Share Males	-0.0123	-0.0120	-0.0119	-0.0116	-0.0119	-0.0115
	(0.0269)	(0.0269)	(0.0269)	(0.0269)	(0.0269)	(0.0269)
Share Managers	4.1376***	4.1045***	4.1600***	4.0834***	4.0787***	4.1361***
	(0.9128)	(0.8769)	(0.9282)	(0.8609)	(0.8550)	(0.9062)
Exporter	0.0027	0.0031	0.0028	0.0029	0.0031	0.0026
	(0.0064)	(0.0064)	(0.0064)	(0.0064)	(0.0064)	(0.0064)
Constant	-0.8231	-0.7987	-0.8472	-0.7755	-0.7854	-0.8340
	(0.9192)	(0.8837)	(0.9344)	(0.8679)	(0.8623)	(0.9127)
Observations	49,673	49,673	49,673	49,673	49,673	49,673
Within R-squared	0.146	0.145	0.146	0.146	0.145	0.146
Number of Firms	6,997	6,997	6,997	6,997	6,997	6,997
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Region Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Age Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Education Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Occupation Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is the log of firm-level total factor productivity (TFP). TFP for manufacturing firms is constructed from Cobb-Douglas production function estimated by the Wooldridge (2009) method of the Levinsohn and Petrin (2003) approach using intermediate inputs as the proxy variable for the unobserved firm-specific productivity shock.

Independent variables: $\ln\left(s^{f,eweducdur}\right)$ is the firm-level ethnicity-education-duration-weighted R&D capital stock based on foreign workers from $OECD^+$ countries. $\ln\left(s^{f,eweducdur,basic\ education}\right)$ is the firm-level ethnicity-education-duration-weighted R&D capital stock based on foreign workers with basic education from $OECD^+$ countries. $\ln\left(s^{f,eweducdur,secondary\ education}\right)$ is the firm-level ethnicity-education-duration-weighted R&D capital stock based on foreign workers with secondary education from $OECD^+$ countries. $\ln\left(s^{f,eweducdur,tertiary\ education}\right)$ is the firm-level ethnicity-education-duration-weighted R&D capital stock based on foreign workers with tertiary education from $OECD^+$ countries. $\ln\left(s^{f,eweduc,unclassified\ education}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers with unclassified education from $OECD^+$ countries. $\ln\left(s^{f,eweduc,unknown\ education}\right)$ is the firm-level ethnicity-weighted R&D capital stock based on foreign workers with unknown education from $OECD^+$ countries. *Workforce Ethnic Diversity* is the firm-level workforce ethnic diversity measure. ln(*Average Firm Tenure*) is the log of average firm tenure (in years) across all employees. *Share Males* is the share of men employees, as a proportion of total workers employed. *Share Managers* is the share of managers employed, as a proportion of total workers employed. *Exporter* is a dummy variable that takes value 1 if the firm exports and zero otherwise. *Firm Age Controls* is a full set of shares of employees belonging to each age distribution quartile. *Firm Education Controls* is a full set of shares of employees with basic, secondary, and tertiary education. *Firm Occupation Controls* is a full set of shares of employees belonging to low-skilled, medium-skilled, high-skilled, and military-skilled occupations.

Standard errors, clustered at the firm-level, are reported in parenthesis.

*: Significant at the 10% level. **: Significant at the 5% level. ***: Significant at the 1% level.