Global Engagement and the Occupational Structure of Firms

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Abstract: Global engagement can impact firm organization and the occupations a firm needs. We examine the effect of globalization on occupational mix using Swedish data covering all firms and a sample of the labor force for 1997-2005. We find a robust relationship, with more globally engaged firms using a mix skewed toward skilled occupations. Moreover, firms have a more skill-intensive distribution when exporting to far away markets, or when exporting differentiated goods. The cross-firm difference in occupational mix and a higher share of skilled workers in higher-wage firms contributed to 19% of overall wage dispersion in 1997 and 26% in 2005.

JEL: F1, F2

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1. Introduction

Profits are the *raison d'être* for firms. Toward this end, firms undertake a variety of tasks in addition to production including *inter alia* research, financial management, logistics, marketing, and sales. Each of these activities, including actual production, requires the input of workers who are trained in various occupations (e.g., production managers, foremen, computing professionals, mechanics, and filing clerks). It is likely that the mix of occupations required to undertake economic activities varies across firms. In particular, the tasks required to support a multinational enterprise (MNE) are likely to differ from those required to support a non-MNE that exports, which in turn are likely to differ from a firm that has no global engagement. However, a decade after Melitz (2003), "[t]he productivity of the firm remains largely a black box and we still have relatively little understanding of the separate roles played by production technology, management practice, firm organization and product attributes towards variation in revenues across firms" (Melitz and Redding, 2014).[1] In this paper we aim at shedding light on the organization of production within firms, as captured by the distribution of occupations, and its relationship with a firm's international orientation.

Our empirical investigation focuses on workers that are included within a firm's boundaries. We use comprehensive and detailed Swedish matched employer-employee data spanning the period 1997-2005. The data include all Swedish firms with at least 20 employees and detailed information on a representative sample of the labor force. In particular, we have information on the occupations for all included employees at a very detailed level (100 occupations). We are therefore able to examine how the degree of a firm's global integration relates to the distribution of occupations within the firm.

Initial results are displayed in Figure 1 which shows the aggregate distribution of occupations by skill levels for three different firm types: (*i*) the most integrated ones – MNEs; (*ii*) the least integrated ones – Local firms (i.e., non-MNEs that do not export); and (*iii*) the intermediate firm type – Exporters (i.e., non-MNEs that export). The horizontal axis is the percentile ranking of occupations by skill levels, from the least skilled to the most skilled. The vertical axis is the cumulative employment share of the labor force accounted for by the skill category that is indicated on the horizontal axis. Panel (a) shows

[1] See also Arkolakis (2010), who argues that the nature of entry costs to foreign markets remains largely unexplained.

occupations ranked according to the average wage for all firms in 1997 and panel (b) is based on a regression ranking.[2]

Figure 1 reveals that roughly 50 percent of the employees hired by Exporters are in the 50 percent lowest ranked occupations. The corresponding figures for MNEs and Local firms are roughly 40 and 70 percent respectively. Moreover, Exporters have a distribution close to the 45-degree line, meaning that their employees are evenly distributed over occupations by skill categories. Looking at MNEs, it is seen that their distribution is skewed towards high skilled occupations. The opposite is true for Local firms, which have a distribution skewed towards low skilled occupations.

More elaborate econometric estimations in the paper confirm a robust relationship between the degree of international integration and the distribution of occupations at the firm level. The distribution is skewed toward more skilled occupations in MNEs. Non-MNE exporters have a distribution of occupations less skewed toward the skilled compared to multinationals, but more skewed toward the skilled compared to Swedish non-exporters. The difference in occupational mix translates into a 7.8% difference in average wages between MNEs and Local firms, and a 6% difference between Exporters and Local firms. Note that these wage differentials arise from the difference in the occupational structure across firm types rather than from the pay gap between Local firms and MNEs/Exporters within the same occupation. Furthermore, the cross-firm difference in occupational mix and a higher share of skilled workers in higher-wage firms, such as MNEs and non-MNE exporters, contributed to 19.4% of overall wage dispersion in 1997 and 26% in 2005. Thus, the cross-firm difference in occupational mix has important implications for wage inequality (details are given in Section 4.C).

We also find that firms tend to have an occupational structure skewed toward more skilled when they mainly export to markets that are more distant from Sweden in terms of geographic distance, or in terms of differences in bilateral trust or culture. Since exporting to more distant markets tends to involve a higher fixed entry cost, the result is consistent with the Melitz (2003) model that only “better” firms (here interpreted as those with a more skill-intensive occupational mix) are able to overcome the higher fixed cost of entering a foreign market.

[2] The beta ranking is derived from Mincer wage regressions. See Section 2.C. for more details.

Our main results are little changed (1) when we control for firm size, productivity, capital intensity, and firm age; (2) when we control for offshoring and R&D expenditures; (3) when we use the average share of college graduates or other alternative methods to rank occupations by skill levels; (4) when we include continuous measures of global engagement such as export shares, number of export markets, or number of export products; or (5) when we use wage bill shares instead of employment shares. In addition, the results are very similar for manufacturing and non-manufacturing, and for foreign and Swedish MNEs.

In order to explain our empirical results, we develop a decomposition that relates to the literature emphasizing fixed costs associated with internationalization. For instance, Helpman, Melitz and Yeaple (2004) stress the different productivity requirements for engaging in production for domestic sales, export, and foreign direct investment (FDI). Their model suggests that the most productive firms can cover the highest fixed costs and will pursue FDI, firms with intermediate productivity will export, and the least productive firms will produce for the domestic market only.

Motivated by Helpman et al. (2004), our decomposition focuses on the distinction between fixed and variable inputs. We first think of these inputs as being produced by workers in different occupations. We then assume that fixed inputs, needed for internationalization and production, are intensive in professional occupations such as managers and engineers; with variable inputs being intensive in lower-skilled occupations such as clerks and mechanics. It naturally follows that, holding all else equal, firms with a higher share of fixed costs also employ a higher share of high-skilled occupations relative to those with a lower share of fixed cost. From Helpman et al. (2004), the share of fixed cost is positively correlated with the degree of global engagement, we would therefore expect a positive correlation between the degree of engagement and the skill-intensity of occupational mix.[3]

There are few previous theoretical papers that examine the relationship between globalization and the organization of production within firms. One exception is Matsuyama (2007) who constructs a model where factor intensities can differ within products. Production for export is assumed to be more skill intensive than production for domestic sales since export requires "white-collar workers,

[3] As we note in Section 3 and Appendix B, this is only a partial effect since firms with different degrees of global engagement differ along other dimensions (e.g., size, productivity) that also correlate with occupational mix.

particularly those with language skills, international business experiences and/or specialists in export finance and maritime insurance." Matsuyama shows that an increase in the world supply of skilled labor will therefore increase the degree of globalization.

Caliendo and Rossi-Hansberg (2012) construct a model with heterogeneous firms in a monopolistically competitive market. Managers solve problems that production workers are not able to solve and a firm can have many layers of managers where higher layers solve more complicated problems. Adding a layer of managers involves new fixed costs but reduces variable costs. Productivity is endogenous in this model and depends on the number of layers of management. The number of layers is in turn dependent on the demand for the firm's product since the extra fixed cost of layers can only be motivated if the scale of production is sufficiently high. Demand is exogenous and only firms with a large demand for their products can afford enough layers to make the firms so productive that it can cover the fixed cost for exporting.

Our paper also relates to a small but growing empirical literature on globalization and firm organization. For instance, Rajan and Wulf (2006) find that U.S. firms have become flatter over time in that they have fewer layers of management. Moreover, Guadulupe and Wulf (2010) find that trade liberalization makes firms flatten their organizations by removing layers between the CEO and division managers, and by increasing the number of positions that report directly to the CEO, a result that is in contrast with the theoretical predictions by Caliendo and Rossi-Hansberg (2012). Caliendo, Monte, and Rossi-Hansberg (2012) use French firm level data with information on five different occupation categories - three types of management, clerks and blue-collar workers – to examine the wage effect of adding a layer (one of the above categories) or by expanding existing layers. [4] They report that exporters are more likely to add layers than non-exporters, and that firms that exit the export market are more likely to drop layers than firms that continue to export. In addition, new exporters that add layers decrease average wages in existing layers, while exporters that do not add layers increase average wages. Unlike these empirical studies that focus on organizational hierarchy, our work focuses on the occupational mix in firms with different degrees of global engagement.

[4] See also Tåg (2013) for a similar study on layers within firms.

Finally, the previous FDI literature has documented that multinational firms are more skill intensive than domestic firms (e.g., see Markusen 1995 and Barba-Navaretti and Venables 2004 for a survey). Moreover, Bernard and Jensen (1997) and others have provided strong evidence that exporters are more skill intensive than non-exporters. Accordingly, Biscourp and Kramarz (2007), using French firm data, find that an increase in imports results in destruction of production jobs, especially for larger firms. However, due to data limitations, these previous studies usually define production workers as the unskilled and non-production workers as the skilled.[5] Our data allow us to dig deeper into this issue because we have a much finer classification of occupations. We are able to offer new insights that build on previous work. For example, we find that MNEs have higher employment shares than Local firms in nearly all high skilled occupations. In particular, the employment share difference is largest for professionals specialized in finance and sales, computing, and engineering, which account for a 16 percentage point difference in the employment share between MNEs and Local firms. Furthermore, the existing literature largely focuses on manufacturing. In contrast, our study covers the whole economy, including both manufacturing and non-manufacturing industries. Finally, our study also reveals new patterns of the variation in the occupational mix across firms that serve different destination markets or specialize in different export products.

In Section 2 we provide some descriptive statistics of the Swedish matched employer-employee data. In Section 3 we sketch out a simple theoretical framework to understand the empirical facts revealed by our data. Our model suggests systematic differences in occupational mix across firm modalities. We turn to detailed empirical analysis in Section 4 and conclude in Section 5.

2. Data and descriptive statistics

We use register-based matched employer-employee data from Statistics Sweden covering the period 1997-2005. The firm data contain detailed information on all Swedish firms, including variables such as value added, capital stock (book value), number of employees, wages, ownership status, sales, and industry. Moreover, the Regional Labor Market Statistics (RAMS) provide information on education and demographics at the plant level, which we aggregate to the firm level. The worker data

[5] One exception is Handwerker, Kim and Mason (2011) who find that the U.S.-based multinational companies employ a disproportionate larger number of engineers compared to other U.S. establishments.

cover detailed information on a representative sample of the labor force, including full-time equivalent wages, education, occupation (ISCO-88), and gender.[6]

Firm level data on export and import of goods originate from the Swedish Foreign Trade Statistics, collected by Statistics Sweden and are available by products and countries at the firm level.[7] Based on compulsory registration at the Swedish Customs, the data cover all trade transactions from outside the EU. Trade data for EU countries are available for all firms with a yearly import or export of approximately 1.5 million SEK and above. According to the figures from Statistics Sweden, the data cover around 92 percent of total goods trade within the EU. Material imports are defined at the five-digit level according to NACE Rev 1.1 and grouped into major industrial groups (MIGs).[8] The MIG code classifies imports according to their intended use. We use the MIG definition of intermediate inputs as our offshoring variable. The data on information about the nationality of foreign multinational firms operating in Sweden originate from the Swedish Agency for Economic and Regional Growth (Tillväxtanalys). The Agency uses definitions of nationality of firms that are in accordance with definitions in similar data from the OECD and Eurostat. A firm is classified as a foreign-owned MNE if more than 50 percent of the equity is foreign-owned.[9] Finally, Swedish MNEs are defined as those with international trade in goods or services within the corporation.

All data sets are matched by unique identification codes. To make the sample of firms consistent across the time periods, we restrict our analysis to firms with at least 20 employees in the non-agricultural private sector, which are available throughout the period.

A. Distribution of firms

Firms can be classified by their international integration along different criteria. One possible

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[6] The worker data originate from the Swedish annual salary survey (*Lönestrukturstatistiken*). The survey's sampling units consist of firms included in Statistics Sweden's firm data base (FS). A representative sample of firms is drawn from FS and stratified according to industry affiliation and firm size (number of employees). The sample size consists of between 8,000 and 11,000 firms. The Central Confederation of Private Employers then provides employee information to Statistics Sweden on all its member firms that have (i) at least ten employees and (ii) are included in the sample. Firms with at least 500 employees are examined with probability one. The final sample includes information on around 50% of all employees within the private sector.

[7] Many firms in the non-manufacturing sector export goods as defined in our Customs data. Since the Customs data do not include service trade, firms that only export services are classified as non-exporters. However, as will be shown in Section 4.H, our results differ little between manufacturing and non-manufacturing industries.

[8] MIG is a European Community classification of products: Major Industrial Groupings (NACE rev1 aggregates).

[9] Other studies on FDI do not typically find lower cut-off values to matter for the results (see e.g., Barbosa and Louri, 2002).

classification scheme is seen in Figure 2 where the different categories are mutually exclusive. Figures on the share of different firm categories are for the period 1997-2005. The first criterion is ownership, where we distinguish between MNEs or non-MNEs. MNEs can be Swedish or foreign owned. The next criteria is whether the firm is an exporter or only sells to the domestic market, and the final criteria is whether the firm is engaged in offshoring or not.

Most Swedish firms are internationally integrated in at least some respects. About 27 percent of the firms are internationally integrated in all three dimensions: they are MNEs that both export and offshore. A relatively large number of non-MNEs are also engaged in exporting and/or offshoring. For instance, 21 percent of the firms are non-MNEs that are engaged in both exporting and offshoring. Finally, around 30 percent of the firms are not internationally integrated in any dimension.

Moreover, we have data on 8,236,835 individual-year observations divided by firm types and industries. About 46 percent of these individuals work in MNEs that both export and offshore and another 24 percent in non-MNEs that both export and offshore. In manufacturing industries the majority of employees work in the most internationally integrated firms – MNEs that export and offshore, or in non-MNEs that export and offshore. Firms that have low levels of international integration are mainly found in non-manufacturing, especially in Health and Education.

Because the vast majority of MNEs are also engaged in both export and offshoring, and non-MNE exporters tend to offshore at the same time, we group firms into three types which will be used in the analysis: MNEs – defined as multinational firms; Exporters – defined as non-MNEs that export; and Local firms – defined as non-MNEs that do not export.

B. How do firms differ in the distribution of occupations?

We begin by considering twelve broad occupation categories in terms of their functions in production. Table 1 lists the twelve groups ranked from high to low in terms of average wages.[10] Managers, research/business professionals, and technicians are more skilled (have higher average wages and higher education levels) than machine/transportation operators, crafts, clerks, and sales and service workers. Column 2 shows the employment share of these occupation groups. About one-third

[10] See Appendix A for more detail about the grouping of occupations into these twelve broad categories. Appendix Table A1 shows which three-digit occupations are included in a specific occupation category.

of total employment is in the occupations that require more skills.

To examine how multinationals, non-MNE exporters, and Local firms differ in the distribution of occupations, we run the following regression

$$(1) \quad \lambda_{jt}^{k} = \alpha_{M}^{k} M_{jt} + \alpha_{X}^{k} E_{jt} + Z_{jt}\gamma^{k} + D_{i}^{k} + D_{t}^{k} + \varepsilon_{jt}^{k}$$

where i, j, k and t index industries, firms, occupations, and years respectively; λ_{jt}^{k} is the employment share of occupation k at firm j in year t;[11] M_{jt} is an indicator of multinational firms (MNE); E_{jt} is an indicator of non-MNE exporters; Z_{jt} is a vector of firm characteristics that might affect the employment share, including firm size (the number of employees), capital intensity (capital-labor ratio), labor productivity (value added per worker), and firm age; D_{i}^{k} and D_{t}^{k} are occupation-industry and occupation-year fixed effects; and ε_{jt}^{k} is the error term. The occupation-industry fixed effects control for technology differences across industries, and the occupation-year fixed effects control for common macro-level shocks that may affect firm-level employment decisions. Since Local firms are the excluded firm group, the coefficient α_{M}^{k} represents the difference in employment shares between MNEs and Local firms, and the coefficient α_{X}^{k} represents the difference in employment shares between non-MNE exporters and Local firms.

MNEs and non-MNE exporters have a relatively higher employment share of most skilled occupations such as managers, research/business professionals, and technicians, as seen in columns 3-4 in Table 1.[12] Among low skilled occupations, MNEs and Exporters tend to have low shares compared with Local firms. This is seen in occupations such as craft, transportation operators, sales and service workers, and laborers. There are, however, two exceptions: MNEs and Exporters have relatively high shares of machine operators and information-processing clerks. This could indicate complementarity between certain lower skilled and higher skilled occupations. Finally, it is also seen that the difference between MNEs and Local firms is larger than the difference between Exporters and Local firms.

[11] In the rest of the paper our core estimates use employment shares of different occupations. Some empirical work on globalization and labor demand uses changes in wage bill shares as the dependent variable (e.g. Becker et al., 2013 and Hakkala et al., 2014). We therefore also use wage bill shares as a robustness test, but results are basically unchanged (see Section 4.H for more details).

[12] The one exception is other professionals where the share is relatively high in Local firms. As shown in Table A1, “other professional” category mainly includes teaching professionals and nursing professionals.

C. A more detailed look at the occupational mix across firm types

Since skill requirements may vary substantially within the 12 broad occupation groups, we turn to occupation categories at the 3-digit ISCO in order to provide a more detailed analysis of the occupational mix across firm types. After merging occupations with very few observations, we end up with 100 different occupations. We run separate regressions of (1) for each of the 100 occupations. The results are shown in Table A1. The coefficients α_M^k and α_X^k show the differences between MNEs and Local firms, and between Exporters and Local firms in the employment share of occupation *k*. The figures in Table A1 show that MNEs and Exporters differ from Local firms in similar aspects. For instance, the largest negative differences for both MNEs and Exporters, i.e. occupations with the most negative values, are found for Shop, stall and market salespersons (ISCO 521,522); Motor vehicle drivers (ISCO 832); Building finishers and related trades workers (ISCO 713); and Helpers and cleaners (ISCO 912). These relatively low skilled occupations are, hence, occupations that are primarily found in firms that are not internationally integrated. On the other hand, some of the largest positive differences, occupations with relatively large employment shares in MNEs and Exporters, are found for Computing professionals (ISCO 213); Legislators and senior officials (ISCO 111), and Physical and engineering science technicians (ISCO 311). These are all relatively high skilled occupations.

To better illustrate the results, we rank occupations by skill levels. Our preferred measure, the "beta ranking", is based on estimated Mincer wage regressions at the worker level. For each year we run regressions with individual wages as the dependent variable and with experience, experience squared, gender, education, and occupation at the 3-digit level as independent variables.[13] Industry fixed-effects are also included. We then compute the skill level of an occupation using the estimated coefficient for that occupation plus the estimated coefficient on the education dummy that indicates the median education level of workers in the particular occupation. Thus, the betas estimated from Mincer wage regressions combine the returns to education and occupation. In the following analysis we use the ranking for the initial year (1997) of the sample. The results are unchanged when the average ranking

[13] Education is measured at 7 levels: (1) Elementary school; (2) Compulsory school; (3) 2 yrs. of upper secondary school; (4) 3 yrs. of upper secondary school; (5) 4 yrs. of upper secondary school; (6) Undergraduate or graduate college education; and (7) Doctoral degree. Education dummies are defined based on the highest level of education achieved (e.g. "Education 6" equals one if the highest level is undergraduate or graduate college education).

over the entire sample period is used. As a robustness check, we use various alternative ways to measure the skill level of occupations, including the share of college graduates and the mean wage for each occupation in 1997. Because of the concern about the dominant effect of MNEs on wages, we also compute the mean wage for each occupation using the sample of non-MNE firms.[14] Since there are very high correlations between different ranking measures (over 95%), our results are unchanged when the alternative measures are used.

We rank occupations by skill levels from the lowest (k = 1) to the highest (k = 100). For a particular occupation $k = k_0$, we compute the cumulative employment share differential between MNEs and Local firms as $\sum_{k=1}^{k_0} \alpha_M^k$ where α_M^k is the difference between MNEs and Local firms in the employment share of occupation k estimated from (1). In Figure 3 panel (a) we plot the cumulative employment share differential $\sum_{k=1}^{k_0} \alpha_M^k$ against the beta ranking of occupation k_0. This curve has two properties. First, since the sum of employment shares across all occupations should be one for any firm type, it is easy to show $\sum_{k=1}^{100} \alpha_M^k = 0$, meaning that the curve must meet the horizontal axis at the most skilled occupation ("Directors and chief executives"). Second, the slope of this curve reflects the marginal difference in employment shares (α_M^k).[15] If the curve rises at occupation k_0, the marginal difference in employment share of k_0 is positive, meaning that MNEs have a higher employment share of occupation k_0 than Local firms. On the other hand, a declining curve at k_0 indicates a negative $\alpha_M^{k_0}$, which implies that MNEs have a smaller employment share of occupation k_0 than Local firms. Note that no restrictions are imposed on the curvature of this curve.

Two interesting patterns emerge from this plot. First, the curve declines over two-thirds of the occupations at the lower end, indicating that MNEs have a smaller employment share of these occupations than Local firms. Overall, the employment share of these lower skilled occupations is nearly 25 percentage points lower in MNEs than in Local firms. More than half of the difference is

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[14] Some studies find multinational firms to pay higher wages than local firms (see e.g. Heyman et al. 2007).

[15] Note that $\alpha_M^{k_0} = \sum_{k=1}^{k_0} \alpha_M^k - \sum_{k=1}^{k_0-1} \alpha_M^k$ is the difference between MNEs and Local firms in the employment share of occupation k_0. This is the marginal difference in employment shares. Thus, if $\alpha_M^{k_0} < 0$ meaning that MNEs have a smaller employment share of occupation k_0 than Local firms, the cumulative employment share differential declines i.e., $\sum_{k=1}^{k_0} \alpha_M^k < \sum_{k=1}^{k_0-1} \alpha_M^k$. Similarly, the cumulative employment share differential increases if MNEs have a bigger employment share of a particular occupation than Local firms.

attributable to three occupations: Motor-vehicles drivers (ISCO 832; $\alpha_M^k = -5.95\%$); Building finishers and related trade workers (ISCO 713; $\alpha_M^k = -4.46\%$); and Shop, stall and market salespersons and Fashion and other models (ISCO 521, 522; $\alpha_M^k = -5.39\%$). On the other hand, this lower-end portion of the curve also has a small jump at Material-recording and transport clerks (ISCO 413; $\alpha_M^k = 2.01\%$). This difference in employment share is relatively large compared to the average employment share of 1.96 percent for the whole economy, and could arise from the need by MNEs to operate a more complex production and sales network than Local firms.

Second, for one-third of the occupations at the higher end, the curve is almost monotonically increasing, which indicates that for these occupations, MNEs have higher employment shares than Local firms (see footnote 15). Since these higher skilled occupations are mostly professionals and managers, the result suggests that the pattern displayed by Table 1 holds for more detailed occupation classifications. As shown in Table A1, the employment share difference is largest for professionals specialized in finance, sales and business (ISCO 341, 241), computing (ISCO 213, 312), and engineering (ISCO 311, 214). The difference in the employment share for these six professional occupations is almost 16 percentage points between MNEs and Local firms.

Figure 3 panel (b) displays the cumulative employment share differential between non-MNE exporters and Local firms against the beta ranking of occupations. The key patterns are similar to those in panel (a). Compared to Local firms, non-MNE exporters have smaller employment shares of less skilled occupations and higher employment shares of more skilled occupations. Comparing the two plots in panels (a) and (b), we can see that MNEs have a distribution of employment even more skewed toward skilled, and the difference from Local firms in skill distribution is even larger.

In panels (c) and (d) we show the plots based on the estimates of α_M^k and α_X^k when firm characteristics are controlled for. After adding the controls, the difference in skill distribution between MNEs and Local firms becomes slightly smaller, suggesting that part of the difference between MNEs and local firms is due to differences between these firm types in terms of firm productivity, size, capital intensity, and firm age. However, the key patterns remain. A similar observation can be made for panel (d) for the difference between non-MNE exporters and Local firms.

3. A Conceptual Framework

Before continuing our exploration of the data, we develop a conceptual framework to better understand why we might expect systematic differences in the occupational structure of employment across firms with different characteristics. Our framework builds on the Melitz (2003) model of selection into exporting as modified by Helpman et al. (2004) to account for multinationals.[16]

Let $\mathbf{x} = (\mathrm{x}_1, \cdots, \mathrm{x}_\mathrm{n})$ be a vector of characteristics that describe a firm. Characteristics could be exogenous or endogenous; continuous or discrete; observable or unobservable. Examples include productivity, distance to market, whether the firm is an exporter, age, capital stock, and so on. All of these factors potentially affect the firm's occupational mix and production costs.

Given market conditions each single-product firm chooses its profit-maximizing output level, denoted by q, which depends on $\mathbf{x}$. We assume that firms hire workers to fill particular occupational categories and define a production function $q(\mathbf{x}) = F(L^1, \cdots, L^K, \mathbf{x})$, where L^k represents the number of workers employed in occupation k. Letting w^k represent the occupation-specific wage, the firm's occupational structure is the solution of the following cost-minimization problem:

$$(2) \qquad \min_{(L^1,\cdots,L^K)} \sum_{k=1}^{K} w^k L^k \qquad \qquad subject\ to\ F(L^1, \cdots, L^K, \mathbf{x}) \geq q$$

From (2), we can write occupation-specific employment as $L^k(q, \mathbf{x})$, emphasizing that it is a function of the firm's vector of characteristics.[17] Summing over all occupations, we obtain the firm's total employment, which we denote as $L(q, \mathbf{x}) = \sum L^k(q, \mathbf{x})$.

In addition to classifying employment by occupation, we can also classify employment according to whether it is fixed or variable. In principle, any given occupation can consist of both components. For example, a large firm may employ more managers than a small firm, but all firms need at least one manager. Using subscripts to represent fixed and variable and assuming that variable employment of any occupation is proportional to output, we can then define $L_f(\mathbf{x}) = \sum L_f^k(\mathbf{x})$ and $L_v(q, \mathbf{x}) = q \sum L_v^k(\mathbf{x})$. Using this notation, the firm's total employment is represented by (3):

[16] See Appendix B for a brief outline of the Helpman et al. (2004) model.

[17] Occupation-specific employment also depends on the vector of occupation-specific wages; however we take that vector as unchanged throughout the analysis. This allows us to simplify the notation.

(3) $L(q,\mathbf{x}) = L_f(\mathbf{x}) + L_v(q,\mathbf{x})$.

In accord with our empirical work, define $\lambda^k(q,\mathbf{x})$ as employment in occupation k as a share of the firm's total employment. This share can be decomposed into three parts. The first part is fixed employment as a share of the total, represent by $\Lambda_f(q,\mathbf{x}) \equiv L_f(\mathbf{x})/L(q,\mathbf{x})$. The remaining two parts are the employment of workers in occupation k relative to all workers associated with fixed employment and relative to all workers associated with variable employment. We use $\lambda_f^k(\mathbf{x}) = L_f^k(\mathbf{x})/L_f(\mathbf{x})$ and $\lambda_v^k(\mathbf{x}) = L_v^k(\mathbf{x})/L_v(\mathbf{x})$ to represent these components. Using this notation:

(4) $\lambda^k(q,\mathbf{x}) = \Lambda_f(q,\mathbf{x})\lambda_f^k(\mathbf{x}) + \left(1 - \Lambda_f(q,\mathbf{x})\right)\lambda_v^k(\mathbf{x})$.

Our interest is in describing how occupational mix varies with a firm's characteristics. Toward that end, consider two different firms defined by $(q^j, \mathbf{x}^j)$ and $(q^{j\prime}, \mathbf{x}^{j\prime})$. From (4):

(5) $\lambda^k(q^{j\prime},\mathbf{x}^{j\prime}) - \lambda^k(q^j,\mathbf{x}^j)$

$$= \Lambda_f(q^{j\prime},\mathbf{x}^{j\prime})\{\lambda_f^k(\mathbf{x}^{j\prime}) - \lambda_f^k(\mathbf{x}^j)\} + \{1 - \Lambda_f(q^{j\prime},\mathbf{x}^{j\prime})\}\{\lambda_v^k(\mathbf{x}^{j\prime}) - \lambda_v^k(\mathbf{x}^j)\}$$

$$+ \{\Lambda_f(q^{j\prime},\mathbf{x}^{j\prime}) - \Lambda_f(q^j,\mathbf{x}^j)\}\{\lambda_f^k(\mathbf{x}^j) - \lambda_v^k(\mathbf{x}^j)\}$$

The decomposition in (5) reveals that the difference in occupational structures of two firms results from a combination of effects. Specifically, the two firms differ in their use of occupations within fixed and variable employment (the *within* effect); and they differ in their balance between fixed and variable employment (the *between* effect).

We need to add some structure to the problem in order to sign the left-hand side of (5). As in our empirical work, we order occupations such that occupation 1 is the least skilled, and occupation *K* is the most skilled. We then make several assumptions.

Assumption 1: For any vector of characteristics $\mathbf{x}^j$, $\lambda_f^k(\mathbf{x}^j) - \lambda_v^k(\mathbf{x}^j)$ is weakly increasing in the occupational index. Because $\sum_k \lambda_f^k(\mathbf{x}^j) = \sum_k \lambda_v^k(\mathbf{x}^j) = 1$, there exists an occupation $\hat{k}$ such that $\lambda_f^k(\mathbf{x}^j) \geq \lambda_v^k(\mathbf{x}^j)$ for $k \geq \hat{k}$, and $\lambda_f^k(\mathbf{x}^j) \leq \lambda_v^k(\mathbf{x}^j)$ for $k < \hat{k}$.

The essence of this assumption is that fixed employment is relatively intensive in the use of more skilled occupations. For example, we typically think of fixed costs as involving marketing, research and development, and management, all of which require highly skilled workers; whereas variable costs are tied to production, which requires operators and other low-skilled workers. This assumption does not preclude the possibility that occupations are used in the same proportions in both fixed and variable employment. Moreover, $\hat{k}$ may itself be a function of $\mathbf{x}^j$.

Assumption 2: Define three types of firms: Local firms that serve only the domestic market (*D*), those that serve the domestic market and export (*E*) and those that are multinational (*M*). As in Helpman et al. (2004), we assume that fixed employment is highest for *M* and lowest for *D*.

In terms of (4), Assumption 2 means that $\Lambda_f(q, \mathbf{x}^M) > \Lambda_f(q, \mathbf{x}^E) > \Lambda_f(q, \mathbf{x}^D)$, where the three firms all have the same characteristics except for their status as multinational, exporter, or domestic. Combining Assumptions 1 and 2 and focusing only on the between effect, we conclude that firms that are more globally engaged use larger shares of occupations $k \geq \hat{k}$. This is a ceteris paribus result as it disregards the within effects and neutralizes any between-firm differences other than the additional fixed employment needed to sustain greater international engagement.

In his model generalizing trade costs, Matsuyama (2007) makes the argument that supplying a foreign market requires more intensive use of workers with expertise in languages, export finance, and maritime insurance, all of which are associated with relatively skilled occupations.[18] We incorporate this argument in the following assumption.

Assumption 3: The share of high-skilled occupations used in fixed and variable employment is weakly increasing in international engagement. That is, there exists $\hat{k}_f$ such that $\lambda_f^k(\mathbf{x}^M) \geq \lambda_f^k(\mathbf{x}^E) \geq \lambda_f^k(\mathbf{x}^D)$ for $k \geq \hat{k}_f$; and there exists $\hat{k}_v$ such that $\lambda_v^k(\mathbf{x}^M) \geq \lambda_v^k(\mathbf{x}^E) \geq \lambda_v^k(\mathbf{x}^D)$ for $k \geq \hat{k}_v$.

Given Assumptions 2 and 3, the within and between effects work in the same direction for $k \geq max(\hat{k}, \hat{k}_f, \hat{k}_v)$ and $k \leq min(\hat{k}, \hat{k}_f, \hat{k}_v)$. In particular, $\lambda^k(q, \mathbf{x}^M) \geq \lambda^k(q, \mathbf{x}^E) \geq \lambda^k(q, \mathbf{x}^D)$ for $k \geq max(\hat{k}, \hat{k}_f, \hat{k}_v)$; and $\lambda^k(q, \mathbf{x}^M) \leq \lambda^k(q, \mathbf{x}^E) \leq \lambda^k(q, \mathbf{x}^D)$ for $k \leq min(\hat{k}, \hat{k}_f, \hat{k}_v)$. The relationship between occupational share and global engagement is ambiguous for occupations $min(\hat{k}, \hat{k}_f, \hat{k}_v) < k < max(\hat{k}, \hat{k}_f, \hat{k}_v)$ since the within and between effects offset each other. This range of ambiguity is consistent with Figure 3, where the relationships between the differences in cumulative employment

[18] Matsuyama (2007) considers only the difference between domestic sales and exports.

shares and occupational rankings for firm types are clear for low-ranking and high-ranking occupations, but less clear for occupations with mid-range skill ranking.

In Melitz (2003), firms self-select into exporters or non-exporters according to productivity. The highest productivity firms have the lowest marginal cost, allowing them to reach a large enough export market to overcome the fixed costs of exporting. Helpman et al. (2004) extend the analysis to include MNEs firms, demonstrating that the most productive firms select into MNE status, somewhat less productive firms export, and the least productive firms only serve the domestic market.[19] In both models, differences in productivity only appear in variable cost. We maintain that assumption here.

<u>Assumption 4</u>: Productivity differences between firms only affect variable employment, not fixed employment. Specifically, let φ represent productivity. Then $L_f(\mathbf{x}^j) = L_f(\mathbf{x}^i)$ and $L_v(\mathbf{x}^j) = \frac{\varphi_{j'}}{\varphi_j} L_v(\mathbf{x}^{j'})$ where productivity is the only difference between j and j'.

If we combine the modeling strategy of Melitz (2003) or Helpman et al. (2004) with our first two assumptions, there would be an indirect relationship between a firm's productivity and its occupational structure. The most productive firms would be multinationals, and these firms would use the highest share of the most skilled occupations. Similarly, holding both international engagement and output constant, Assumption 4 implies that more productive firms would have a higher share of fixed inputs and therefore employ a higher share of the most skilled occupations. However, it is conceivable that there does exist a more direct relationship between productivity and occupational structure. For example, productivity may be embodied in capital equipment with the operation of more productive (and presumably more sophisticated) equipment requiring the use of higher-skilled occupations. In this way of thinking, technology and productivity would be a choice made by firms, as in Yeaple (2005). We therefore make the following assumption.

<u>Assumption 5</u>: The share of high-skilled occupations within fixed and variable employment is weakly increasing in productivity. That is, there exist $\hat{k}_{f\varphi}$ and $\hat{k}_{v\varphi}$ such that $\lambda_f^k(\mathbf{x}^{j'}) \geq \lambda_f^k(\mathbf{x}^j)$ for $k \geq \hat{k}_{f\varphi}$ and $\lambda_v^k(\mathbf{x}^{j'}) \geq \lambda_v^k(\mathbf{x}^j)$ for $k \geq \hat{k}_{v\varphi}$ if the only difference between j and j' is that $\varphi_{j'} > \varphi_j$.

[19] One drawback of Helpman et al. is that firms can only be exporters *or* multinationals, not both. This is counterfactual. We address this issue in Appendix B.

Suppose that $\varphi_{j'} > \varphi_j$. From Assumption 4, $\Lambda_f(q, \mathbf{x}^{j'}) - \Lambda_f(q, \mathbf{x}^j) > 0$. That is, the more productive firm has a higher share of fixed employment. This implies from Assumption 1, that the between effect increases the more productive firm's share of occupations $k > \hat{k}$. The within effect reinforces the between effect for occupations at the high and low end of the skill spectrum. Specifically, $\lambda^k(q, \mathbf{x}^{j'}) - \lambda^k(q, \mathbf{x}^j) \geq 0$ for $k \geq max(\hat{k}, \hat{k}_{f\varphi}, \hat{k}_{v\varphi})$ and $\lambda^k(q, \mathbf{x}^{j'}) - \lambda^k(q, \mathbf{x}^j) \leq 0$ for $k \leq min(\hat{k}, \hat{k}_{f\varphi}, \hat{k}_{v\varphi})$. The sign of $\lambda^k(q, \mathbf{x}^{j'}) - \lambda^k(q, \mathbf{x}^j)$ is indeterminate for $min(\hat{k}, \hat{k}_{f\varphi}, \hat{k}_{v\varphi}) < k < max(\hat{k}, \hat{k}_{f\varphi}, \hat{k}_{v\varphi})$ since the between and within effects offset each other.

The distance to the firm's market may also influence its mix of occupations. We may interpret distance literally to represent the geographic distance to market, or figuratively to represent cultural distance. In either case, we might surmise that relatively more skilled occupations are required to bridge greater distances, making the within effect positive. However, further distances likely require larger amounts of both fixed and variable inputs, and it is not clear how the balance between the two changes. Therefore, the between effect is ambiguous. It follows that the total effect of distance is also ambiguous.

Finally, we compare firms of different size. To do so, suppose that $\mathbf{x}^{j'} = \mathbf{x}^j \equiv \mathbf{x}$ while $q^{j'} > q^j$. Since $\lambda_f^k(\mathbf{x}^j)$ and $\lambda_v^k(\mathbf{x}^j)$ are both independent of output, the within effect is zero. However, $\Lambda_f(q^{j'}, \mathbf{x}) < \Lambda_f(q^j, \mathbf{x})$, while $\lambda_f^k(\mathbf{x}^j) \geq \lambda_v^k(q^j, \mathbf{x}^j)$ for $k \geq \hat{k}$. The between effect implies that larger firms have a relatively smaller share of occupations $k \geq \hat{k}$.

We gather the above results in Table 2. The entries in this table represent the expected sign of $\lambda^k(q^{j'}, \mathbf{x}^{j'}) - \lambda^k(q^j, \mathbf{x}^j)$ for high-skilled occupations as we change one variable at a time. High-skilled occupations are defined as $k \geq max(\hat{k}, \hat{k}_f, \hat{k}_v)$ when comparing firms with different degrees of global engagement; $k \geq max(\hat{k}, \hat{k}_{f\varphi}, \hat{k}_{v\varphi})$ when comparing firms with different productivity; and $k \geq \hat{k}$ when comparing firms of different size.

The entries in the far right column of the table represent the expected total effect on occupational use of the most skilled occupations given a change in a single variable, holding all others constant.[20] However, (4) is constructed to allow for arbitrary differences between firms. It becomes more difficult to make unambiguous comparisons of occupational structures between firms when multiple characteristics can vary. As a simple example, consider Melitz (2003). As noted above, more productive firms are larger than less productive firms, and only the most productive firms can export. In terms of our notation, if $\varphi_{j'} > \varphi_j$, it follows that $q_{j'} > q_j$ and (if firms differ in export status), $j' = E$, and $j = D$. From Table 2, the facts that j' is more productive than *j* and is an exporter whereas *j* serves only the domestic market both suggest that we would expect j' to employ a higher share of skilled occupations than *j*. But the fact that j' is also larger than *j* suggests the opposite, that j' employs a smaller share of skilled occupations compared with *j*.

4. Firm-level Results

A. Empirical specification

Rather than running regressions of employment shares separately for 100 occupations, in the following empirical analysis the dependent variable will be an index that summarizes the skill level of the occupational mix at a firm. Specifically, we compute S_{jt}, the skill index for firm *j* in year *t* as

(6) $$S_{jt} = \sum_k \lambda_{jt}^k s^k$$

where s^k represents the skill level of occupation *k* and λ_{jt}^k is the employment share of occupation *k* at firm *j* in year *t*. We measure the skill level of occupation *k* in the following ways: (1) the average log wage for *k*; (2) the average share of college graduates for *k*; and (3) the skill percentile ranking of *k* (a higher *k* meaning a more skilled occupation), where occupations are ranked based on the betas estimated from Mincer wage regressions, average wages of all firms, or average wages of only non-MNEs (see Section 2.C for details). The skill index is higher if employment is allocated more toward higher skilled occupations. Moreover, since s^k is fixed for a specific occupation *k*, the cross-firm difference in the skill index reflects the difference in occupational mix rather than the skill difference within occupations. Finally, the index based on the skill percentile ranking of occupations is bounded between zero and one, and similar to the index used by Zhu and Trefler (2005) to measure the skill content of a country's

[20] The expected changes for the lowest-skilled occupations are the reverse, with the expected change in usage of mid-range occupations is indeterminate.

exports. A value of 0.5 indicates that employment is evenly distributed across all occupations.[21]

The main specification is

(7) $$S_{jt} = \delta_M MNE_{jt} + \delta_X Exporter_{jt} + Z_{jt}\gamma + D_i + D_t + \mu_{jt},$$

where D_i and D_t are industry and year fixed effects respectively; and μ_{jt} is the error term. Local firms are the excluded group. Thus, δ_M represents the difference in the skill index between MNEs and Local firms, and δ_X represents the skill difference in between non-MNE exporters and Local firms.

Specifications (1) and (7) are closely related. Given the definition of S_{jt}, it is straightforward to show that δ_M and δ_X are weighted sums of α_M^k and α_X^k respectively, where the weight is s^k (the skill level of occupation *k*).

B. Main Results

Table 3 displays the estimation results. In column 1 the skill index is computed using average log wages for 1997 as a proxy for skills. The estimated coefficients on MNE and Exporter indicate that relative to Local firms, the average wage is about 7.8 percent higher by MNEs and 6 percent higher by Exporters. Note that these wage differentials reflect the difference in the occupational structure across firm types rather than the wage gap between MNEs and Local firms or between Exporters and Local firms within the same occupation. Since the employment at MNEs and Exporters is skewed toward more skilled and better paid occupations, these numbers show us on average how much more MNEs or non-MNE exporters need to pay their workers given their difference in the skill distribution of occupations from Local firms.

There is a concern that wages could be confounded by rent sharing between firms and workers (e.g. Frías et al. 2009 and Helpman et al. 2012). Thus, in column 2 we measure the skill level of occupation *k* using the average share of college graduates for *k* in 1997. The coefficients on MNE and Exporter suggest that compared to Local firms, the share of college graduates is on average 4 percentage points higher in MNEs and 3 percentage points higher in non-MNE exporting firms. The difference between MNE/Exporters and Local firms is even greater when we use the average share of college

[21] This is a limiting result as the number of occupations tends to infinity. For a finite number of occupations, the lower limit of the index is $1/K$, and $S_{jt} = \frac{1}{2}\frac{K+1}{K}$ when $\lambda_{ft}^k = \frac{1}{K}$ for all *k*.

graduates for later years to capture skill level. However, since there is large variation in skills even among college graduates, our preferred measure of skill level of occupations will be the betas estimated from Mincer wage regressions that combine the returns to education and occupation.

In columns 3-5 we use the skill index based on the skill percentile ranking of occupations where occupations are ranked by betas estimated from Mincer wage regressions (beta ranking), average wages of all firms, and average wages of non-MNEs. Since these rankings are closely correlated, the estimates are very similar. It is seen that both MNEs and Exporters have a higher skill index than Local firms, irrespective of how occupations are ranked.

Overall, Table 3 reveals a robust pattern that the occupational mix is more skilled intensive for MNEs and Exporters than for Local firms. It is also seen that the distribution of occupations is more skewed towards higher skilled for MNEs than for Exporters: the estimated coefficient for MNE is statistically larger in all estimations based on standard *t*-tests. The result is robust to our different ranking criteria for skills and to inclusion of firm level characteristics. Finally, our size variable has a negative and statistically significant coefficient in all estimations, and labor productivity is significantly correlated with skill intensity of a firm.

C. Economic significance

Differences in the occupational structure across firm types have important implications for wage inequality. The variation in occupational mix not only contributes to average wage differentials between firm types (see column 1 of Table 3 as discussed above), but also is an important factor contributing to the overall wage dispersion, as will be shown below.

We start with a standard decomposition of the overall wage dispersion into dispersion within firms (each firm has a mix of occupations with different skills and wages) and dispersion between firms (average wages vary across firms). Specifically, overall wage dispersion can be written as

$$\sum_j \sum_h \left(w_{h(j),j} - \bar{w}\right)^2 = \sum_j \sum_h (w_{h(j),j} - w_j)^2 + \sum_j E_j (w_j - \bar{w})^2$$

where $w_{h(j),j}$ is the log wage of worker h employed at firm j, w_j is the average log wage at firm j, E_j is employment at j, and $\bar{w}$ is the average log wage for the whole economy. The first term represents within-firm wage dispersion, and the second term represents between-firm wage dispersion.

Between-firm wage dispersion can come from three sources: (1) given the same occupational wages, firms have different occupational mix; (2) given the occupational mix, firms pay different wages to workers with the same occupation; and (3) the covariance between the difference in occupational mix and within-occupation wage differentials. Thus, we decompose the between-firm wage dispersion:

$$\sum_j E_j\left(w_j - \bar{w}\right)^2 = \sum_j E_j\left(w_j^* - \bar{w}\right)^2 + \sum_j E_j\left(w_j - w_j^*\right)^2 + 2\sum_j E_j[(w_j^* - \bar{w})(w_j - w_j^*)]$$

where $w_j^* = \sum_k w^k \lambda_j^k$ is the hypothetical average log wage at firm *j* if *j* pays w^k (the average log wage of all firms for occupation *k*) to workers with occupation *k*, given the occupational mix captured by λ_j^k. We note that w_j^* corresponds to the skill index defined in equation (6) and computed using average log wages of all firms as a proxy for skills.

Since $w_j^* - \bar{w} = \sum_k w^k(\lambda_j^k - \lambda^k)$, the first term of the between-firm wage dispersion decomposition captures the contribution of varying occupational mix to wage dispersion (with occupational wages being held constant at w^k). Thus, the first term is referred to as the between-occupation component.

Since $w_j = \sum_k w_j^k \lambda_j^k$ (where w_j^k is the log wage paid by firm *j* to workers with occupation *k*) and thus $w_j - w_j^* = \sum_k(w_j^k - w^k)\lambda_j^k$, the second term instead allows cross-firm variation in occupational wages with the occupational mix held at λ_j^k. The second term is thus referred to as the within-occupation component.

The sign of the third term (called the cross term) is interesting. The cross term is positive for firms that allocate a bigger share of workers toward highly paid jobs compared with the national average ($w_j^* - \bar{w} = \sum_k w^k\left(\lambda_j^k - \lambda^k\right) > 0$) if those firms also pay a higher wage across the board ($w_j - w_j^* = \sum_k\left(w_f^k - w^k\right)\lambda_f^k > 0$).[22] In the previous section, we established a strong pattern that MNEs and non-MNE exporters tend to have an occupational mix more skewed toward skilled compared to Local firms. The data also reveal that MNEs and non-MNE exporters pay slightly higher wages than Local firms within occupations. Thus, we expect the cross-term to be positive. A positive sign of the cross term

[22] The cross term is also positive if firms tend to allocate a smaller share of workers toward highly paid jobs ($w_f^* - \bar{w} < 0$) *and* pay a lower wage across the board ($w_f - w_f^* < 0$).

reflects some degree of assortative matching between firms and workers. That is, higher-wage firms employ a higher share of skilled workers than lower-wage firms.

Figure 4 displays the three components of between-firm wage dispersion as a share of overall wage dispersion. It is seen that an increasing share of the overall wage dispersion is attributable to the between-firm dispersion (27.1% in 1997, 34.4% in 2005). This pattern is consistent with what Lazear and Shaw (2009) report for many countries. Figure 4 also reveals that the contribution of the within-occupation component to overall wage dispersion is relatively small and constant (7.7% in 1997, 8.3% in 2005). By contrast, the between-occupation component is relatively large and increasing over time (15% in 1997, 19.3% in 2005). The cross term is positive and increasing (4.5% in 1997, 6.7% in 2005), indicating that there is increasingly assortative matching between firms and workers. [23] Overall, the cross-firm difference in occupational mix and a higher share of skilled workers in higher-wage firms contributed to 19.4% of overall wage dispersion in 1997 and 26% in 2005.

D. Export destination markets

The fixed costs of export, and thereby the distribution of occupations, might differ across export markets (Blanes-Cristóbal et al. 2008; Arkolakis 2010; Gullstrand 2011; Jienwatcharamongkhol 2014). For instance, exporting to markets that are more remote in terms of geographic distance, culture, preferences and business climate might require more fixed costs for marketing and logistics. It is therefore possible that the mix of occupations varies between firms that export to different markets.

We start to examine this issue in Table 4 where we include a number of variables that capture aspects of differences between Sweden and a firm's main export market. The main export market is defined as the country to which a firm has its highest export. We include population weighted geographic distance and differences in GDP per capita, the latter are used to capture differences in preferences. Moreover, we include a measure of how much Swedes trust people from other countries and a measure of how much Swedes are trusted by people from other countries. We also include two measures of cultural differences compared to Sweden: the traditional vs. secular variable that captures the contrast between societies where religion is important and those where it is not; and the survival vs.

[23] See also Davidson et al. (2012 and 2014) for evidence of an increase over time in assortative matching.

self-expression variable that is associated with the transition from industrial to post-industrial societies and reflects the differences in values ranging from survival (i.e., an emphasis on economic and physical security above all) to self-expression (i.e., an emphasis on subjective well-being, self-expression and the quality of life). These two variables explain more than 70% of the cross-cultural variance on scores of more specific values according to the World Values Surveys. Finally, rule of law in other countries is used as a measure of institutional differences.[24] We expect that closeness to Sweden (geographic distance or differences in culture/preferences), high levels of bilateral trust, and good institutions in the destination markets reduce the need for the fixed costs of creating and maintaining contractual arrangements, thereby reducing the need for high-skilled occupations.

Column 2 of Table 4 shows that the estimated coefficient for geographic distance is positive and statistically significant, suggesting that firms that have their main export market far away from Sweden have an occupational structure skewed toward more skilled. This result is consistent with the Melitz model that only "better" firms (here interpreted as those that have a more skill-intensive occupational mix) are able to overcome a higher entry cost of entering a far-away export market. We note that those firms are paying a higher wage bill (due to a more skilled workforce) and incurring a higher shipping cost (due to a longer distance). To be profitable, those firms must be more productive. Our result also sheds light on the well-established fact in the gravity literature: the total trade volume is strongly and negatively related to distance. As implied by our result, only "better" firms are able to enter the export market when the distance rises. Thus, the total trade volume is reduced for more distant markets. This is the "extensive margin" of trade in response to distance, and is consistent with the finding by Bernard et al. (2011) that all the negative effect of distance on bilateral trade flows is accounted for by the extensive margins of the number of exporting firms and exported products.

As an alternative we have also run separate regressions for different export markets. Unreported regressions support our results on the relationship between distance and the occupational structure: the distribution of occupations is relatively less skilled for firms that export to closer markets (e.g., Northern

[24] Data on distance are based on CEPII's measure, which is a weighted measure taking into account internal distances and population dispersion (Mayer and Zignago 2006); GDP per capita is from Penn World Tables; Cultural differences from World Value Surveys; Bilateral trust from Guiso et al. (2009); and Rule of law from Worldwide Governance Indicators (WGI). Bilateral trust measure is only available for 14 European countries.

and Western Europe), and relatively skilled for those that export to more distant markets (e.g., Asia, North America).[25] We have also analyzed exporters to specific countries. There is, again, a positive relationship between distance and the skill level of occupations: exporters to European countries have less skilled labor mix compared to exporters to the U.S., China, and Japan.

Countries that are geographically close tend to be more similar in culture and income levels, and have a higher level of bilateral trust. This view is borne out in the data as shown in Table A2 in the Appendix: countries close to Sweden tend to have similar income levels as Sweden, and share similar religious beliefs. In addition, citizens in Nordic countries tend to have more trust toward Swedes and Swedes tend to have more trust toward people in Nordic countries. We include specific measures that capture these aspects in columns 3-6 to examine the effect of different aspects of destination markets. Because these measures are highly correlated, we enter them separately in the regressions to avoid multicollinearity. As shown in columns 3-4, coefficients on bilateral trust are negative and statistically significant, suggesting that firms with their main export market to countries which are relatively trusted by Swedes, or whose citizens trust Swedes relatively more, tend to have a distribution of occupations skewed toward less skilled. This result implies that a higher level of bilateral trust may reduce the need for the fixed costs of creating and maintaining contractual arrangements, making it easier for "weaker" firms (less skilled intensive) to enter a foreign market. Thus, our result provides micro-level evidence supporting the view by Guiso et al. (2009) that lower bilateral trust reduces trade flows.

Columns 5-6 report results when cultural differences are included. Our two measures of cultural differences give mixed results. The coefficient for differences in secular vs. traditional values is positive and statistically significant, suggesting that firms with exports to countries that differ from Sweden in this respect have a more skilled labor mix. However, the measure of the survival vs. self-expression values is statistically insignificant.

Columns 7-8 show that neither the rule of law nor income levels (a proxy for preferences) are significantly correlated with skill distribution of exporters to the particular market.

Except for income levels, all the other measures of differences between Sweden and the main

[25] The results are available upon request.

export markets are time invariant. To fully capture unobserved characteristics of destination markets, in column 9 we include country fixed effects. The coefficients on the MNEs and Exporters are reduced by about half, indicating that the firm-level skill distribution of occupations varies substantially across firms that serve different main destination markets. In order to illustrate whether the destination fixed effects are systematically related to some of the observed country characteristics examined in columns 2-8, we plot the estimated destination fixed effects against those observed country characteristics in Figure 5. A bigger destination fixed effect indicates that exporters to that particular market on average have a more skilled labor mix.

Panel (a) of Figure 5 plots destination fixed effects against the log of geographic distance from Sweden. We exclude main destination markets that attract fewer than 20 exporters. We can see that almost all the destinations have fixed effects greater than zero. Hence, exporters, irrespective of their main export market, always have a more skilled labor mix than Local firms. In addition, there is a clear positive relationship between geographic distance and destination fixed effects,[26] which is consistent with our previously discussed correlation between distance and exporters' occupational mix: the distribution of occupations is skewed toward less skilled for exporters to closer markets, such as the Nordic countries, West- and East Europe, and is skewed toward higher skilled for exporters to more distant markets such as South Europe, America, Africa, Asia, and Oceania.

Panel (b) of Figure 5 shows a strong and positive relationship between destination fixed effects and a measure of cultural differences (traditional vs. secular values). Panels (c) and (d) plot destination fixed effects against measures of bilateral trust between Swedes and other European nationalities. We can see that destination fixed effects are smaller as bilateral trust is higher (recall that the destination fixed effects reflect the average skill level of occupational mix for exporters to a particular destination). Portugal is an outlier to this relationship. When it is excluded, the negative relationship between destination fixed effects and bilateral trust becomes more statistically significant.

[26] As shown in Table A3 in the Appendix, destination fixed effects are positively related to geographic distance for the full sample of 120 destination markets, although this relationship becomes stronger when we drop destinations that attract fewer than 20 exporters. When we run the weighted least square regressions where the weight is the number of exporters to a particular market, the result differs little whether we use the full sample or the sample of destinations that attract more than 20 exporters.

Both Table 4 and Figure 5 suggest that firms with their main export market in countries more distant from Sweden tend to skew employment toward more-skilled occupations. The distance can be in terms of geographic distance, or in terms of differences in bilateral trust or culture. All these factors may increase trade frictions. Thus, the evidence suggests that only firms with a more skill-intensive occupational mix are able to overcome those frictions and export to more distant markets.

E. Export product markets

The amount of fixed investments, and thereby occupational mix, might differ between firms that specialize in different export products. It is, for example, plausible that more differentiated goods require adaptation to local markets and regulations to a larger extent than homogenous products, which in turn will have an impact on organization and occupational mix. Moreover, Rauch (1999) argues that trade in differentiated goods involves more search costs, which should also have an impact on firm organization. We therefore examine the occupational mix across firms that export different types of goods. We follow Rauch (1999) and separate exports into differentiated, reference priced, and organized exchange (homogenous goods).[27] We adopt the 'liberal' classification that maximizes the number of goods classified as organized exchange or reference priced when ambiguities arise.[28] Homogenous goods are those traded on organized exchanges. Reference priced products are not traded on organized exchanges but still possess reference prices. All the other goods are defined as differentiated. We then divide both MNE and non-MNE exporters into the three categories based on their main exports.[29]

Columns 1-3 in Table 5 show results where a firm's main export is respectively differentiated, reference priced, and homogenous. As in previous estimations, the comparison group is Local firms. We find that non-MNE exporters of all three types of goods have a higher skill index than Local firms and a lower skill index than MNEs. Moreover, as expected, exporters of differentiated products have more skilled labor mix than exporters of other products. The difference between exporters of

[27] The classification of goods can be found at:
http://www.macalester.edu/research/economics/page/haveman/Trade.Resources/TradeData.html#Rauch

[28] See the note to Table 5 for details on how exporters are classified into the three categories.

[29] We are unable to identify the types of goods produced by MNE non-exporters and Local firms. We thus include them in all the regressions reported in Table 5. Given the small percentage of MNE non-exporters in the sample, the results are little changed when MNE non-exporters are excluded from the regressions. In all the regressions, Local firms are the comparison group.

homogenous products and reference priced products is small and statistically insignificant.[30]

Another way of looking at product markets is to group exports into capital goods, intermediate inputs, and final consumption goods. Capital goods might, for instance, be more technology-intensive than final consumption goods, thereby requiring a different set of occupations. In columns 4-6 of Table 5 we group exporters according to their main export categories – capital goods, intermediates, and consumption goods, respectively.[31] In each column, we compare them with Local firms. We find that the difference in the skill level of occupational distribution is largest between exporters (including both MNE and non-MNE exporters) of capital goods and Local firms, and is the smallest between exporters of final consumption goods and Local firms.

F. Alternative explanations

Offshoring: We previously discussed offshoring as an additional dimension of international integration. Some previous studies have examined the impact of imports of intermediate goods on the labor market (see e.g. Goos, et al. 2009 for European countries, Liu and Trefler 2011 for the U.S., and Hummels et al. 2014 for Denmark). In Table 6 we examine whether offshoring has an impact on occupational mix. Offshoring is measured by imported inputs as a share of total sales. As shown in column 2, inclusion of offshoring share has little impact on our main results. The coefficient for offshoring is statistically insignificant, suggesting that our main result is not driven by the possibility that MNEs or Exporters are more able to offshore low skilled tasks than Local firms. It should be noted that 91% of Exporters and 82% of MNEs are engaged in offshoring. Hence, it is possible that the effect of offshoring is captured by the MNE and Exporter variables. Dropping these two variables makes the offshoring variable statistically significant with a coefficient of 0.045 (see column 3).

The relationship between offshoring and the occupational mix is not uniform across firm types. In column 4 we interact the offshoring share with firm types. Now the coefficient for offshoring represents the effect of offshoring for Local firms. The coefficients for the interaction between the

[30] Using the alternative 'conservative' classification, which minimizes the number of goods classified as organized exchange or reference priced in cases of ambiguities, has no major impact on the results with the exception that the coefficient for export of homogenous (organized exchange) goods becomes statistically insignificant.

[31] This classification is based on BEC (Broad Economic Categories). More information on BEC can be found at: http://unstats.un.org/unsd/cr/registry/regcst.asp. See the note to Table 5 for details on how exporters are classified into the three categories.

offshoring share and the other two firm types indicate the differential effect of offshoring between MNEs and Local firms[32], or between Exporters and Local firms. Interestingly, offshoring has a significantly positive relationship with the skill distribution of occupations for Local firms, but not for MNEs or Exporters. This result suggests that compared with Local firms that do not offshore, Local firms that engage in offshoring might need to incur some fixed costs, e.g., searching for suitable foreign suppliers or tweaking existing production lines to fit imported inputs. As a result, the composition of workforce in those firms is skewed toward higher skilled occupations. By contrast, both MNEs and non-MNE exporters might have made such fixed investments in order to break into a foreign market. Offshoring decisions could be a part of their international expansion strategies. Our results suggest that the effect of offshoring could be subsumed in the effect of exporting or FDI.

Overall, we find that our main results are unchanged after controlling for offshoring. Offshoring activities appear to have very modest effect on occupational structure. Even for Local firms, the estimated effect of offshoring on occupational mix is small. Given the average share of offshoring in total sales is just 0.013 among Local firms that have offshored, these Local firms on average have a skill index 0.006 ($= 0.452 \times 0.013$) higher than Local firms that do not offshore. All these results are little changed when we use the average share of college graduates or other alternative methods to measure the skill level of occupations.

Innovation: Technological innovation is associated with organizational changes and calls for a higher skilled labor mix (Caroli and van Reenen, 2001; Bresnahan el al. 2002). Thus, in column 5 of Table 6 we include R&D intensities to examine if the higher skilled labor mix in MNEs and Exporters is caused by engagement in innovation activities that require highly skilled professionals. The coefficient on R&D intensity is positive and significant, showing that high shares of R&D increase the share of high skilled occupations. In column 6, we add the interaction between R&D intensities and firm types. We find that the effect of R&D on the occupational mix does not differ significantly between firm types. For all firm types, R&D intensity is strongly and positively related to the skill mix. On the other hand, in columns 5-6 the coefficients on MNE and Exporter dummies are not significantly different from the benchmark

[32] As suggested by Figure 2, about 10% of Local firms purchased intermediate inputs from abroad.

estimates as shown in column 1. Hence, MNEs and Exporters have a distribution of occupations skewed toward more skilled even after controlling for firm differences in R&D intensity. Therefore, although we find a strong positive relationship between R&D intensity and skill mix at the firm level, the systematic pattern of the skill distribution across firms with different degree of international engagement remains little changed.

G. Switchers

In the above we have focused on the variation across firms in their occupational mix. We now turn to the question about possible changes in occupational mix when a firm switches type. We examine three types of switches: from Local to Exporter; from Local to MNE; and from Exporter to MNE. Around 11.3% of the stock of Local firms switch into a non-MNE exporter in the following year and 2.6% into an MNE. The corresponding figure for the change from a non-MNE exporter to an MNE is 5.2%. Thus, only a small number of firms switch types in our sample.

Because switchers may be different from non-switchers prior to their change in firm type, we include firm fixed effects to control for unobserved firm characteristics. This is different from the specification used in previous estimations. Results are reported in Table 7. Columns 1-4 include firms that switch from Local to Exporter and those that remain as Local throughout the sample period. In column 1 *Change in firm type* is a dummy variable which equals one for the year when the transition occurs and thereafter, and equals zero before the transition. The coefficient on *Change in firm type* captures the change in the skill index as a result of the switch from a Local to an Exporter. We find a significant positive effect of this switch on the skill mix, although the estimate of 0.024 is smaller than the difference in skill index between Local and Exporters reported in Table 3.

In columns 2-4 we analyze the dynamics of the relationship between firm types and the occupational mix by examining how the effect is spread over time. The firm fixed-effects regression reported in column 2 examines whether the occupational structure started to change prior to the transition, where *Change t-1* is a dummy for the year before the change in firm type, and *Change t*-2 is a dummy for the period that is two years prior to the change. Note that the base period for comparison is the period that is more than two years prior to the change in firm type. Compared to the base period, we find no significant shift in the occupational mix for the years prior to the change of firm type. In column 3, we study the over-time change in occupational mix after the switch of firm type. We now include a dummy for the year when the change occurs, *Change t=0*, and three dummies capturing the periods after the change of firm type: *Change t+1* is a dummy for the first year after the change, *Change t+2* for the second year after the change, and *Change>t+2* indicates the period that is more than two years after the change. In this column the base period is the period prior to the switch of firm type. The results in column 3 show an instant positive, although not significant, effect of the change in firm type. Interestingly, this effect increases over time, with positive and significant estimates for the following periods. In the fourth column, we allow for changing effects both before and after the switch of firm type. Now the base period is the one that is more than two years prior to the change in firm type. Consistent with previous results, there is no significant effect before the switch, but an increasing impact over time after the switch.

The results in columns 1-4 suggest that adjusting the occupational mix is a slow process. We find modest changes in the skill mix when a firm switches from Local to Exporters. One explanation for the small observed changes in the occupational mix could be that switchers may have changed their occupational mix years before the actual switch takes place. Unfortunately, constrained by the period of our sample (1997-2005), we are unable to observe many years before a firm switches its type. However, based on the information available in our data, we find that switchers have a significantly higher skill mix than non-switchers at least two periods prior to their switch.

Finally, the results in columns 5-12 show that there is no significant change in the skill mix when a Local firm or a non-MNE exporter becomes an MNE. Again, the change in occupations might have taken place a long time before the change of firm type, which is supported in our data. In particular, our data reveal that switchers are more than twice as large as non-switchers several years before the actual ownership change takes place. The difference in firm size between switchers and non-switchers is sustained throughout the sample period.

To summarize, we find modest changes in the skill mix after the change of firm type. Firms changing from Local to Exporter or MNE, or from Exporter to MNE, already have a relatively skilled distribution of occupations several years before the change. The relative increase in the skill distribution continues after a change from Local to Exporter but not after the other types of changes.

Our benchmark estimates as reported in Table 3 should be interpreted as capturing the long-term steady state relationship between firm types and the skill mix. For instance, since most of the Exporters included in the benchmark estimations may have exported for a long period, the benchmark estimates reflect the difference between *established* Exporters and Local firms, which should be stronger than the immediate effect of the switch from a Local to an Exporter.

H. Robustness

Adding Continuous measures of global engagement: As shown in Figure 2, the vast majority of MNEs are also exporters. Both MNEs and non-MNEs may differ in export intensity, the number of products they export, and the number of export destination markets served. We add continuous measures of export activities in Table 8 to capture this variation in the degree of global engagement among firms. As seen from Table 8, firms with increasing export activities in terms of export share of total sales, the number of goods exported, and the number of foreign markets served tend to have a higher skill index. On the other hand, adding these continuous measures of global engagement has very little impact on the coefficients for MNE and Exporter, which could suggest that global engagement affects the occupational mix largely through fixed costs. In the paper we do not include these continuous measures to keep our specification parsimonious, and instead focus on the contrast between firm types.

Are Swedish and foreign MNEs different? In our analysis we pool both Swedish and foreign owned multinational firms. It is possible that outward and inward FDI have different effects on firm organization and the distribution of occupations. For example, Swedish owned MNEs might conduct more R&D and have more levels of management. We therefore repeat our previous estimations but with multinational firms divided between foreign and Swedish owned. As shown in column 1 of Table 9, both foreign and Swedish owned MNEs have a relatively skilled labor mix and there is no statistically significant difference between them.

There might be differences among foreign MNEs headquartered in different countries if, for example, the distance between the home country and Sweden impacts the operations of affiliates. In order to examine the role of the nationality of foreign MNEs, we have matched our firm-level data with data from the Swedish Agency for Economic and Regional Growth (Tillväxtanalys) which contain information about the nationality of foreign owned MNEs operating in Sweden.[33]

We start by comparing Swedish MNEs with foreign MNEs from different regions. Columns 2-4 show that Non-European MNEs have a more skilled occupational mix than Swedish MNEs while European MNEs (both from Europe as a whole and from EU-15 countries) are slightly less skilled intensive than Swedish MNEs. We also find that on average MNEs from OECD countries and developed countries have a slightly less skilled occupational mix than Swedish MNEs (columns 5-6).[34] Hence, foreign MNEs have on average a similar distribution of occupations as Swedish MNEs. Although there is variation in the occupational mix across foreign MNEs, the difference tends to be small and statistically insignificant.

Are manufacturing different from non-manufacturing? Next we divide our sample into manufacturing and non-manufacturing firms. Results are presented in Table 10. Because manufacturing industries have very few Local firms (i.e., non-MNEs that do not export), in columns 1-2 we compare MNEs with non-MNEs (most of which are exporters).[35] MNEs have a more skilled labor mix than non-MNEs. The difference between MNEs and non-MNEs is 0.025 in column 1 (without firm control), and 0.018 in column 2 (with firm control). The magnitude is similar to the difference in the estimated coefficients on MNE and Exporter dummies as reported in columns 1-2 of Table 3 for all industries.

The result for non-manufacturing, where we have more firms in the category of Local firms, is also in line with previous results. Compared to the estimates for all industries, MNEs and Exporters have an even higher skill levels than Local firms.

Controlling for size differences: One key difference between different firm types is their sizes.

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[33] Data on nationality of firms can be found at http://www.tillvaxtanalys.se/en/home.html. The main owner's place of origin defines the nationality, which is in accordance with definitions by OECD and Eurostat.

[34] We have also examined the occupational mix in MNEs from individual countries. To be specific, we divided our foreign MNEs by their country of origin for the 11 largest investors: 9 European and 2 non-European countries. Seven of the countries have MNEs with a less skilled occupational mix than Swedish MNEs and four with a more skilled labor mix, but most of the differences are statistically insignificant. Finally, MNEs from all countries have more skilled labor mix than local firms and only MNEs from Denmark have a statistically significant lower skilled occupational structure compared to Exporters. Results are available upon request.

[35] For instance, only in Printing and Publishing do we have a more substantial share of Local firms (24 percent). In other manufacturing industries the share of employees in Local firms ranges from 0 percent (Basic Metals) to 4 percent (Food, Beverages and Tobacco).

Multinational firms tend to be relatively large and Local firms tend to be relatively small. This can be seen from Figure 2: MNEs account for 34.4% of firms and 56% of employment while Local firms (i.e., non-MNEs that do not export) account for 33.9% of firms and just 14% of employment. Although we control for firm size in our previous estimations, we still could fail to account for the following aspects: large firms may have a larger set of occupations than much smaller firms; and a variation in data coverage of workers within firms. Thus, we include a number of additional estimations in Table 11 to examine the robustness of our results when we consider a difference in size between firm types. More precisely, column 1 shows the result when we only include firms with more than 5 occupations; columns 2-4 examine firms with more than 10, 20, or 50 employees. In column 5 we only include firms where we have information at the worker level on at least 75% of the firm's employees. [36]

The results show that our previous conclusions are not altered when we look at samples of firms in different size classes: international integration is positively related to the distribution of skills.

Using wage bill shares instead of employment shares: As previously noted, our index is constructed by weighting the skill ranking of occupations using the employment shares in these occupations. So our results are driven by differences in the employment allocation rather than the wages across firm types. Now we repeat our estimations with our index constructed using wage bill shares as weights. Results in Table 12 show that the alternative measure yields similar results: MNEs have a more skilled labor mix than Exporters, and both of these firm types have a higher skill index than Local firms. The small difference in the results is that the coefficients for MNEs and for Exporters are somewhat larger in Table 12. This result reflect the fact that MNEs and Exporters pay relatively high wages for the most skilled employees and relatively low wages for the least skilled employees, a result that is partly supported in previous studies (Heyman et al. 2007, 2011 and Schank et al. 2007).

5. Concluding Remarks

The availability of firm level data has transformed the field of international trade over the past 20 years. Focus has shifted away from industry analysis and now rests squarely on the firm. While we

[36] Note that our sample includes firms with more than 20 employees according to balance sheet information in the firm data. However, we may observe less than 20 individual workers from the worker data for the firms with more than 20 employees.

have learned a great deal (see Melitz and Redding 2013 for a survey) there is still much to explore. As we noted in the introduction, we know very little about the nature of the fixed costs that firms must overcome to gain access to global markets and we are just beginning to explore how the organizational structure of the firm is affected by globalization. Moreover, one would expect that changes in organizational structure (as documented by Rajan and Wulf 2006 and Guadalupe and Wulf 2010) would lead firms to alter the occupational mix of workers that they employ. For example, a firm that begins to export will likely need to hire new employees in occupations such as logistics and marketing. Or, a firm that sells goods on world markets through foreign affiliates will require information on foreign preferences, laws, regulations, distribution networks and a host of similar issues; and collecting such information requires a different set of occupations than producing for the domestic market. Examining such organizational changes requires quite detailed firm-level data that includes information about the occupation of workers employed by each firm. In this paper we made use of an extensive, remarkably rich data set to examine one of these issues. In particular, we provided compelling evidence that the occupational mix of firms is systematically related to the degree to which they are globally engaged. Our main finding is that the most globally engaged firms (MNEs) are relatively intensive in the use of more skilled occupations whereas local firms (Swedish non-exporters) skew their mix toward less skilled occupations. Non-MNE exporters fall in between, using a more skill-intensive mix of occupations than local firms, but less skill-intensive occupation than MNEs. The difference in occupational mix translates into a 7.8% difference in average wages between MNEs and Local firms, and a 6% difference between Exporters and Local firms. Furthermore, the cross-firm difference in occupational mix and a higher share of skilled workers working in higher-wage firms such as MNEs and non-MNE exporters contribute to 19.4% of overall wage dispersion in 1997 and 26% in 2005.

We develop a conceptual framework designed to help us tease out the forces that are likely generating our results. We show that the shift towards a more skill-intensive workforce may be motivated by several factors including the need to cover new fixed costs as a firm increases its global engagement and the fact that more productive firms are likely to be more globally engaged. The first effect follows from an assumption that fixed costs make use of more skilled occupations (management and professionals) than variable costs (production workers), giving rise to what we call the “between effect" – differences in the occupational mix used by firms tied to their balance between fixed and variable employment. The second result follows naturally from a framework such as Helpman et al. (2004) in which heterogeneous firms self-select into different organizational structures. Our assumption is that the more productive firms in the Helpman et al. framework make use of more sophisticated technologies that rely more heavily on high-skilled occupations than their low-productivity counterparts. This gives rise to a "within effect" that relates differences in the occupational mix used by firms to their use of occupations within fixed and variable employment. Our analysis speaks only to the total effect that global engagement has on the occupational mix; further empirical work is needed to tease out the relative importance of the within and between effects.

Though not explored here, our findings suggest interesting general-equilibrium effects of globalization on income distribution. To the extent that trade costs fall and more firms become globally engaged, we might expect to see increased demand for more skill-intensive occupations relative to less skill-intensive occupations with the consequent change in their relative rewards.

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Appendix A

Occupations in our data are based on the *Swedish Standard Classification of Occupations* (*SSYK96*) which in turn is based on the *International Standard Classification of Occupations (ISCO-88).* SSYK3 and ISCO88 are more or less identical at the 3-digit level with only a few exceptions. A conversion key between SSYK96 and ISCO88 are available at Statistics Sweden: http://www.scb.se/Grupp/Hitta_statistik/Forsta_Statistik/Klassifikationer/_Dokument/oversattningsnyckel.pdf.

In the context of ISCO-88 and SSYK96 a "job" is defined as "a set of tasks and duties which are (or can be assigned to be) carried out by one person." Occupations are grouped together and aggregated on the basis of the similarity of skills required to fulfill the tasks and duties of the jobs (see e.g. Hoffmann, 2004). Detailed descriptions of occupations can be seen from the *International Labor Organization* (ILO) website: http://www.ilo.org/public/english/bureau/stat/isco/isco88/major.htm. In Table 1, we group 100 occupations (at the three-digit level) into twelve broad categories based on the similarity of tasks and duties and the skills required to carry out them. Appendix Table A1 lists which 3-digit occupations are included in each of the broad categories. As shown in Table 1 in Hoffmann (1994), Managers, Professionals, and Technicians require higher skill levels, and Clerks, Sales and service workers, Craft, Operators, and Laborers require lower skill levels.

Appendix B

Our conceptual framework is an extension of Helpman et al. (2004), which is itself an extension of Melitz (2003). Here we provide a brief, intuitive explanation of the structure of Helpman et al. (2004) and note two modifications that bring it closer to the data.

Consistent with the bulk of the large literature on monopolistically-competitive models of international trade, Helpman et al. (2004) assume that homogeneous labor is the only input. In essence, there is only one occupation. The amount of labor required for firm j is represented by equation (B.1):

$$(B.1) \quad L^j = f^j + \frac{\tau^j q^j}{\varphi}, \qquad j = D, E, M$$

where τ^j represents iceberg transportation costs. They assume $\tau^j > 1$ for exporters, and $\tau^j = 1$ for domestic firms and multinationals. They further rank fixed costs such that $f^D < f^E < f^M$.

Assuming CES preferences, it is well known that the profit-maximizing price is a fixed markup over marginal cost, which is decreasing in productivity; and that variable profit is increasing in productivity. Only the most productive firms can generate enough variable profit to enter a foreign market by means of exporting or FDI. Moreover, there is a proximity-concentration tradeoff between exporting and FDI since exporters have lower fixed costs but higher variable costs compared with multinationals. This tradeoff resolves in favor of becoming a multinational firm if productivity is sufficiently high, otherwise the globally-engaged firm chooses to export.

There are two minor issues to be considered when using this framework to think about the data. First, all relevant outcomes depend uniquely on the productivity parameter. In particular, once this is known, the firm's status as an exporter, multinational, or domestic firm becomes completely determined. There are no low-productivity multinationals or high-productivity domestic firms. This issue can be resolved by assuming that once firms know the result of the productivity lottery, they draw another random shock that affects their ability to export or to become multinational. Let ξ represent a random shock with mean value equal to zero. Then we can re-write (B.1) as follows:

$$(B.2) \quad L^j = f^j + \frac{\tau^j q^j}{\varphi} + \xi^j, \; j = D, E, M.$$

With this formulation, it is possible that two firms with the same productivity could make different choices about global engagement. In practice, we could think of ξ as capturing some unobserved variation. For example, personal networks might allow one firm to negotiate favorable tax treatment to establish a subsidiary, with that tax treatment being denied to an otherwise identical firm.

The second problem is that within the Helpman et al. framework each firm is uniquely identified as either being an exporter *or* a multinational (or neither). In fact, as seen in Figure 2, this is counterfactual. Almost all multinational firms are also exporters. We could of course have models of vertically integrated firms, shipping intermediate parts back and forth between a foreign subsidiary and domestic parent. But there is also an interpretation of Helpman et al. that is consistent with the data. Consider a firm that faces multiple foreign markets and assume that iceberg transportation costs and/or the fixed costs of entering the market via exporting or FDI vary by location. It is entirely consistent with the model that the firm would choose to export to some markets while establishing subsidiaries in others. Unfortunately, our data is not sufficiently detailed to test this conjecture.