THE IMPACT OF A FIRM’S SHARE OF EXPORTS ON REVENUE, WAGES, AND MEASURE OF WORKERS HIRED

— THEORY AND EVIDENCE

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Abstract

This paper links an extension to the Melitz (2003) model that allows for a firm’s export status to be continuous to the Helpman et al. (2010) framework of heterogeneous firms in a global economy. A change in a firm’s share of exports triggered by a decrease in trading costs can then be accounted for changes in its revenue, its average wage as well as its measure of workers hired. The predictions of the model are ultimately borne out by the LIAB1, a German linked employer-employee data set.

Key words: International Trade, Firm Heterogeneity
JEL classification: F12, F16, E24

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1This study uses the cross-sectional model of the linked employer-employee data (LIAB) (Version 2, Years 2000-2008) from the Institute for Employment Research (IAB). Data access was provided via on-site use at the Research Data Centre (FDZ) of the German Federal Employment Agency (BA) at the IAB and subsequently remote data access.
1 Introduction

While recent models of heterogeneous firms in a global economy only allow for firms to have a binary export status (non-exporting or exporting), we argue that a firm’s precise share of exports is of large additional value when trying to assess the key drivers behind its revenue, its average wage or the measure of its workers hired.

Our argumentation is borne out by an extended Melitz (2003) model in which we loosen the symmetry assumption in order to allow for countries with different aggregate expenditures and different aggregate prices. Thanks to this asymmetry, some firms will — after drawing their initial productivity — be able to export to a few countries, while other, more productive firms, are even able to export to more countries and will hence have a higher share of exports. We further link our extended model to the recently developed Helpman et al. (2010) framework, henceforth HIR, so as to establish a connection between a firm’s share of exports and its revenue, its average wage rate as well as its measure of workers hired.

Ultimately, we use the LIAB, a linked employer-employee panel data set from Germany, in order to empirically test our model’s reliability. For this purpose, we run fixed effects regressions of the firm specific variables mentioned above on the share of exports with and without controls for certain firm specific characteristics. While a dummy variable for the firm’s binary export status is perceptive to changes in the extensive export margin, our results show that already very small changes in the intensive export margin can be accounted for relatively large changes in the variables of interest.

The plan of this paper is as follows. Section 2 presents the theoretical framework. In Section 3 we describe the data set used. Section 4 contains our empirical results. Section 5 concludes. An Online Appendix provides the most important derivations.

2 Theoretical Framework

2.1 A Firm’s Productivity

Our model consists of a world with a home country and \( n \) asymmetric countries, while the asymmetry stems from different distributions of firm productivity across countries. In this way, a country \( c \)'s firm productivity is assumed to be Pareto distributed with the continuous cumulative distribution

\[
G_c(\varphi) = 1 - \left( \frac{\varphi_{\min,c}}{\varphi} \right)^{z_c} \quad \text{for } \varphi > \varphi_{\min,c} \text{ and } z_c > 1 \quad \text{for all } c = 1, \ldots, n + 1,
\]

where less productive countries have a higher \( z_c \) and/or a smaller \( \varphi_{\min,c} \).

As in the Melitz (2003) model, after entering the market, each firm \( k \) in industry \( s \) draws their initial productivity parameter \( \varphi_{csk} \)\(^2\) from \( g_c(\varphi) \) with support over \([\varphi_{\min,c}, \infty)\),

\(^2\)For reasons of simplicity we henceforth suppress the country, industry, and firm subscript \( c, s, \text{and } k \) whenever possible.
where the draw of a productivity level that is not sufficient to serve the domestic market, i.e. \( \varphi < \varphi^*_{d,c} \), will force a firm to immediately exit the market. Though in contrast to Melitz (2003), from the point of view of the home country there are now \( n \) different export cutoff productivity levels \( \varphi^*_{x,c} \) for each foreign country \( c = 1, \ldots, n \). Without loss of generality, we can arrange the cutoff levels in ascending order, where 1 corresponds to the country with the lowest export cutoff productivity level. Accordingly, a domestic firm with a productivity \( \varphi \), so that \( \varphi^*_{x,1} < \varphi < \varphi^*_{x,1} + 1 \), can export to the least productive countries. However, since firms can only export if they produce for their domestic market, we get \( \varphi^*_{d,c} \leq \varphi^*_{x,1} \). We further assume no price discrimination and an equal elasticity of substitution \( \sigma = 1/(1 - \rho) \), with \( 0 < \rho < 1 \), for each industry across countries.

2.2 Worker Ability

We assume worker ability to be independently distributed across countries and to be drawn from a Pareto distribution with the continuous cumulative distribution

\[
G_{a,c}(a) = 1 - \left( \frac{a_{\min,c}}{a} \right)^{\zeta_c} \quad \text{for} \quad a > a_{\min,c} \quad \text{and} \quad \zeta_c > 1 \quad \text{for all} \quad c = 1, \ldots, n + 1.
\]

As in HIR, before hiring, firms will pay search costs of \( bm \) in order to be randomly matched with \( m \) workers. Since worker ability is unobservable beforehand, firms have to pay screening costs of \( \varepsilon a^\delta / \delta \), where \( \varepsilon > 0 \) and \( \delta > 0 \), to identify from those \( m \) workers the ones that have at least an ability of \( a^\varepsilon \). For more productive firms will set the screening threshold higher, \( a^\varepsilon \) is dependent of \( \varphi \), i.e. \( a^\varepsilon(\varphi) \).

2.3 A Firm’s Revenue And Export Decision

Following HIR, the production side abide by a simple Cobb-Douglas function and is stated as follows

\[
y(\varphi) = \varphi h^\gamma \bar{a}, \quad (1)
\]

where \( h = m(a_{\min,c}/a^\varepsilon)^\zeta_c \) is the measure of workers hired, \( 0 < \gamma < 1 \), and \( \bar{a} = \zeta_c a^\varepsilon/(\zeta_c - 1) \) the average ability of the firm’s workforce. This leads to

\[
y(\varphi) = \varphi \frac{\zeta_c}{\zeta_c - 1} a^\gamma_{\min} m^{\gamma} a^{1-\gamma \zeta_c}.
\]

The revenue of a firm in the home country that is producing a variety \( \omega \) and is exclusively serving the domestic market can thereby be written as\(^3\)

\[
r_d(\omega) = y_d(\omega)p_d(\omega) = y_d(\omega)^\rho I_d^{1-\rho} P_d^\rho = y_d(\omega)^\rho A_d, \quad (2)
\]

where \( I_d \) is domestic income, \( P_d \) the domestic aggregate price, and \( A_d \) a domestic demand shifter that is linked to the total average productivity \( \bar{\varphi}_t \), which includes all domestic

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\(^3\)See the Online Appendix, Part A, for a derivation.
and foreign firms of the home country, via (A.1)\(^4\). The quantity \(y_d(\omega)\) is given by the Marshallian demand functions and is stated as follows\(^5\)

\[
y_d(\omega) = p(\omega)^{-\sigma} P_d^{\sigma-1} I_d = \left( \frac{p(\omega)}{P_d} \right)^{-\sigma} \frac{I_d}{P_d} = \left( \frac{w}{P_d \rho} \right)^{-\sigma} \frac{I_d}{P_d},
\]

As can be seen, with increasing productivity, a firm’s output and thereby its domestic revenue will increase continuously, so as of now we can write (2) as \(r_d(\varphi) = y_d(\varphi)^\sigma A_d\).

In an analogous way to HIR, a firm that has then drawn a productivity sufficient to export to \(c'\) countries, with \(1 \leq c' \leq n\), will allocate its domestic output and its exports to country \(i\) \((y_d \text{ and } y_{x,i})\) to equate its marginal revenue for every market. From

\[
r(\varphi) = r_d(\varphi) + \sum_{c=1}^{c'} r_{x,c}(\varphi) = y_d(\varphi)^\sigma A_d + \sum_{c=1}^{c'} \left( \frac{y_{x,c}(\varphi)}{\tau_c} \right) A_{x,c},
\]

with \(r(\varphi)\) being overall revenue, \(r_{x,c}(\varphi)\) the revenue from export to country \(c\), \(\tau_c\) iceberg trading costs to country \(c\), such that \(\tau_c > 1\) units of a variety must be exported for one unit to arrive in country \(c\)’s market, and \(A_{x,c}\) the demand shifter for country \(c\), we obtain \(c'\) different first-order conditions

\[
\frac{\partial r_d(\varphi)}{\partial y_d(\varphi)} = \frac{\partial r_{x,c}(\varphi)}{\partial y_{x,c}(\varphi)} \Leftrightarrow \frac{y_{x,c}(\varphi)}{y_d(\varphi)} = \tau_c^{\frac{\sigma}{\sigma-1}} \left( \frac{A_{x,c}}{A_d} \right)^{\frac{1}{\tau_c}} \text{ for all } c = 1, \ldots, c'.
\]

Using (3) and (4), we can write a firm’s total revenue as\(^6\)

\[
r(\varphi) = y(\varphi)^\sigma A_d \left( 1 + \sum_{c=1}^{c'} \tau_c^{\frac{\sigma}{\sigma-1}} \left( \frac{A_{x,c}}{A_d} \right)^{\frac{1}{\tau_c}} \right)^{1-\sigma}.
\]

Summing up the right-hand side of (4) over \(c = 1, \ldots, c'\) and linking it to (5) along with the fact that \(y(\varphi) = y_d(\varphi) + y_{x,1}(\varphi) + \ldots + y_{x,i}(\varphi)\) which implies \(y_d(\varphi) = y(\varphi)/\Upsilon\), where

\[
\Upsilon = 1 + \tau_1^{\frac{\sigma}{\sigma-1}} \left( \frac{A_{x,1}}{A_d} \right)^{\frac{1}{\tau_1}} + \ldots + \tau_c^{\frac{\sigma}{\sigma-1}} \left( \frac{A_{x,c}}{A_d} \right)^{\frac{1}{\tau_c}},
\]

leads to\(^7\)

\[
r(\varphi) = y(\varphi)^\sigma A_d \cdot \Upsilon^{\frac{1}{\sigma}} \text{ or equivalently } r(\varphi) = r_d \cdot \left( \frac{\varphi}{\varphi_d} \right)^{\frac{1}{\sigma}} \cdot \Upsilon^{\frac{1}{\sigma}},
\]

with \(r_d\) being the revenue of a non-exporting firm that makes zero profits and \(\Gamma = 1 - \rho\gamma - \rho(1 - \gamma\zeta)/\delta\). As can be seen, more productive firms are able to export to more countries and will hence have in general a higher revenue.

A firm’s profit function can then be written as a combination of its domestic and foreign profits

\[
\pi(\varphi) = \pi_d(\varphi) + \pi_{x,c}(\varphi) = r_d(\varphi) + \sum_{c=1}^{c'} r_{x,c}(\varphi) - b m - \frac{\varepsilon}{\delta} \alpha \delta - f_d - \sum_{c=1}^{c'} f_{x,c}
\]

\(^4\)See the Online Appendix, Part A, for a derivation.

\(^5\)See the Online Appendix, Part A, for a derivation.

\(^6\)See the Online Appendix, Part A, for a derivation.

\(^7\)See the Online Appendix, Part A, for a derivation.
By analogy with the Melitz (2003) model, in the end, a firm will only export to a certain country $c$, with $1 \leq c \leq c'$, if the profits are non-negative, i.e. $\pi_{x,c}(\phi) > 0$. Therefore a firm’s export decision depends not only on its own productivity surpassing the export cutoff level, which is a necessary condition, but also on the demand shifter and the trading costs. By taking this into account, the number of countries a firm is actually exporting to, denoted by $c^*$, can be a smaller than $c'$, i.e. $c^* \leq c'$. However since the Melitz (2003) model assumes constant productivity over time, changes in the share of exports can only occur through changes in the demand shifters or in trading costs.

Bringing trading costs into focus, this framework can explain for two kinds of changes in a firm’s share of exports. In this way, a small decrease in trading costs to countries with a relatively low export cutoff productivity level as well as a considerable decrease in trading costs to high productivity countries can make it profitable for some firms to start exporting to these countries. While highly productive firms with a relatively large share of exports might increase their exports to these countries only slightly, this change in trading costs will mainly affect the extensive margin of exports. On the other hand, an overall decrease in trading costs to high productivity countries will especially affect the intensive margin of exports, for firms already exporting to these countries will find it profitable to increase their output allocated to these countries. Therefore $\Upsilon$ can either change through shifts in the intensive or extensive margin. By bringing trading costs into focus, we state the following proposition:

**Proposition 1:** A decrease in trading costs will increase the firm’s share of exports and thereby its revenue.

### 2.4 Wages

In the following, we again rely on HIR to establish a link between a firm’s average wage and its share of exports. Since the solution to the bargaining game between a firm and its workers yields that the total wage bill is $\rho_\gamma/(1 + \rho_\gamma)$ of the average revenue while the firm keeps $1/(1 + \rho_\gamma)$ of the average revenue, the profit maximization problem for a firm in the home country is defined by

$$
\pi(\phi) = \max_{m \geq 0, a \geq a_{\min}} \left\{ \frac{1}{1 + \rho_\gamma} \left[ 1 + \sum_{c=1}^{c'} \frac{\rho_\gamma}{1 + \rho_\gamma} \left( \frac{A_{x,c}}{A_d} \right)^{1 - \rho} \right]^\gamma - b m - \frac{\varepsilon}{\delta} a_\varepsilon - f_d - \sum_{c=1}^{c'} f_{x,c} \right\},
$$

where $f_d$ and $f_{x,c}$ are fixed production costs for the domestic and foreign market, respectively. For the measure of workers sampled $m$ and the ability threshold $a_\varepsilon$ we derive the

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8A derivation of the solution to the bargaining game can be found in Acemoglu et al. (2007) and in the Technical Appendix to HIR.
first-order conditions of the profit maximization problem:

\[
\frac{\rho \gamma}{1 + \rho \gamma} r(\varphi) = bm(\varphi) \tag{7}
\]

and

\[
\frac{\rho (1 - \gamma \zeta_d)}{1 + \rho \gamma} r(\varphi) = ca_c(\varphi)^\delta \tag{8}
\]

As one can see, firms with a higher revenue will not only sample more workers, but will also set a higher ability threshold. We can use these results along with \( h = m(a_{\text{min},d}/a_c)^\zeta_d \) in order to define the average wage rate

\[
w(\varphi) = \frac{\rho \gamma}{1 + \rho \gamma} \frac{r(\varphi)}{h(\varphi)} = \frac{bm(\varphi)}{h(\varphi)} = b \left[ \frac{a_c(\varphi)}{a_{\text{min},d}} \right]^{\zeta_d} \tag{9}
\]

The relation we get from this last equation is in accordance with the general intuition that firms with a higher revenue will also employ workers with a higher ability level, who will correspondingly be better paid. Using again (4) and (5), we can derive\(^9\)

\[
w(\varphi) = w_d \cdot \left( \frac{\varphi}{\varphi_d} \right)^{\frac{\zeta_d}{\Gamma}} \cdot \frac{\zeta_d}{\Gamma} \cdot \frac{\zeta_d}{\Gamma} \cdot \frac{\zeta_d}{\Gamma} \cdot \frac{\zeta_d}{\Gamma} \cdot \frac{\zeta_d}{\Gamma} \tag{10}
\]

where \( w_d \) denotes the lowest average wage. This leads to our second proposition:

**Proposition 2:** A decrease in trading costs will increase the firm’s share of exports and thereby the average wage paid to its employees.

### 2.5 Measure of Workers Hired

Making once again use of the first-order conditions (7) and (8) along with \( h = m(a_{\text{min},d}/a_c)^\zeta_d \), we can in a similar manner to the average wage rate, derive the firm’s measure of workers hired, namely\(^{10}\)

\[
h(\varphi) = h_d \cdot \left( \frac{\varphi}{\varphi_d} \right)^{\rho (1 - \zeta)} \cdot \frac{\zeta_d}{\Gamma} \cdot \frac{\zeta_d}{\Gamma} \cdot \frac{\zeta_d}{\Gamma} \cdot \frac{\zeta_d}{\Gamma} \cdot \frac{\zeta_d}{\Gamma} \cdot \frac{\zeta_d}{\Gamma} \tag{11}
\]

with \( h_d \) being the lowest measure of workers hired. We state our third proposition as follows:

**Proposition 3:** A decrease in trading costs will increase the firm’s share of exports and thereby its measure of workers hired.

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\(^9\)See the Online Appendix, Part A, for a derivation.

\(^{10}\)See the Online Appendix, Part A, for a derivation.
3 Data

For the empirical part of our study we use the ‘LIAB cross-sectional model 2’, a linked employer-employee data set from the German Institute for Employment Research (IAB).

On the employer side, the LIAB consists of survey data from the annual waves of the IAB establishment panel. The panel’s sample is drawn from the population of all German establishments having at least one employee. It is further stratified according to firm size, industry, and federal state and has a varying firm response rate of 63% to 73% through the years.

Each firm is then classified according to the IAB Establishment Panel Employer Survey into one of 41 industries that are again part of an industry category. Since our main focus lies on the impact of trade, we exclude industries with no primary interest in exports, leading to a panel that consists of firms that belong to the first 25 industries in the IAB classification. These are all industries in the primary and secondary sector as well as industries in ‘Trade and Repair’ and ‘Transport and Communication’.

Furthermore, we exclude firms with less than five workers in a given year, thereby ensuring that our results are not distorted by idiosyncratic factors of these very small businesses. However, we obtain very similar results using the universe of all firms belonging to the above mentioned 25 industries. In order to allow for a better comparability between estimations with and without firm specific controls, we exclude all firms that do not report whether or not their workforce is subject to a collective bargaining agreement. In each year these were so few in number — all together 88 firm-years — that the missing is only noticeable at the fourth decimal place in the regressions’ coefficients. Table I reports firm and employment shares for each industry in the base year 2000.

The information on individual employees stems from two sources. These are in most cases the social security notifications, whereas in some cases the process-generated data of the Federal Employment Agency and the agencies responsible for the implementation of unemployment benefits were used. Throughout the entire data set firms and workers contain a unique identifier. Since the IAB establishment panel is based on annual voluntary surveys, over the years some firms and therefore workers drop out of the panel in order to be replaced by new ones, while others can be followed through the entire panel. We restrict our panel to the years from 2000 to 2008 for a major shift in the IAB classification of establishments in 2000 resulted in such significant changes that a consistent extension to the years before 2000 is not possible. In addition, it is not until 1996 that the annual surveys contain information about East-German firms and workers, which would reduce a second panel to only four observations per industry.

In accordance with other literature, we only include full-time workers with an average daily gross wage exceeding twice the minimum wage\textsuperscript{11} (based on the wages in minor em-

\textsuperscript{11}By imposing this threshold, we follow a suggestion of Klein et al. (2013). The threshold is also very close to the one imposed in Akerman et al. (2013). Note that the mentioned amount is considerably below the social security aid that a non-working person would receive.
employment), which ranges, depending on the year, from 10.56 to 13.15 Euros per day. In this way, workers during vocational training, interns, workers in minor employment, or women during maternity leave will not distort our analysis. Since workers are not obliged to state any additional income above the upper earnings limit, ranging from 144.16 to 173.77 Euros per day, wages within a range of 2 Euros at the limit are estimated according to the imputation procedure of Gartner (2005). We then compute for each firm, each

### Table I

Employment Shares and Relative Mean Log Wages across Industries, 2000

<table>
<thead>
<tr>
<th>Industry</th>
<th>Employment Share</th>
<th>Exporter Share Firms</th>
<th>Share Employment</th>
<th>Relative Mean Log Wage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture, Hunting, Forestry &amp; Fishing</td>
<td>0.55%</td>
<td>0.24%</td>
<td>0.05%</td>
<td>-0.35</td>
</tr>
<tr>
<td>Mining, Electricity, Gas &amp; Water Supply</td>
<td>5.55%</td>
<td>0.23%</td>
<td>1.00%</td>
<td>0.25</td>
</tr>
<tr>
<td>Manuf. of Food Prod.</td>
<td>3.89%</td>
<td>1.53%</td>
<td>2.08%</td>
<td>-0.18</td>
</tr>
<tr>
<td>Manuf. of Textiles &amp; Apparel</td>
<td>1.18%</td>
<td>1.13%</td>
<td>0.85%</td>
<td>-0.14</td>
</tr>
<tr>
<td>Manuf. of Paper Prod., Printing &amp; Publishing</td>
<td>2.40%</td>
<td>1.24%</td>
<td>1.50%</td>
<td>0.19</td>
</tr>
<tr>
<td>Manuf. of Wood Prod. (no Furniture)</td>
<td>1.02%</td>
<td>0.66%</td>
<td>0.63%</td>
<td>-0.16</td>
</tr>
<tr>
<td>Manuf. of Chemicals, Coke &amp; Petroleum</td>
<td>10.11%</td>
<td>2.53%</td>
<td>8.10%</td>
<td>0.17</td>
</tr>
<tr>
<td>Manuf. of Rubber &amp; Plastic Prod.</td>
<td>3.34%</td>
<td>2.02%</td>
<td>2.95%</td>
<td>-0.03</td>
</tr>
<tr>
<td>Manuf. of Other Non-Metallic Mineral Prod.</td>
<td>2.47%</td>
<td>0.99%</td>
<td>1.66%</td>
<td>-0.02</td>
</tr>
<tr>
<td>Manuf. of Basic Metals</td>
<td>6.30%</td>
<td>2.18%</td>
<td>5.15%</td>
<td>0.06</td>
</tr>
<tr>
<td>Recycling</td>
<td>0.20%</td>
<td>0.10%</td>
<td>0.02%</td>
<td>-0.19</td>
</tr>
<tr>
<td>Manuf. of Fabricated &amp; Structural Metal Prod.</td>
<td>5.31%</td>
<td>2.70%</td>
<td>4.00%</td>
<td>0.00</td>
</tr>
<tr>
<td>Manuf. of Machinery &amp; Equipment</td>
<td>11.27%</td>
<td>5.02%</td>
<td>10.23%</td>
<td>0.18</td>
</tr>
<tr>
<td>Manuf. of Motor Vehicles &amp; Trailers</td>
<td>12.39%</td>
<td>1.40%</td>
<td>11.21%</td>
<td>0.06</td>
</tr>
<tr>
<td>Manuf. of Other Transport Equipment</td>
<td>4.28%</td>
<td>0.52%</td>
<td>3.16%</td>
<td>0.13</td>
</tr>
<tr>
<td>Manuf. of Electrical Equipment</td>
<td>6.45%</td>
<td>2.51%</td>
<td>5.49%</td>
<td>0.09</td>
</tr>
<tr>
<td>Manuf. of Precison &amp; Optical Equipment</td>
<td>1.75%</td>
<td>0.80%</td>
<td>1.47%</td>
<td>-0.03</td>
</tr>
<tr>
<td>Manuf. of Furniture, Jewellery &amp; Other Prod.</td>
<td>1.46%</td>
<td>1.13%</td>
<td>1.30%</td>
<td>-0.08</td>
</tr>
<tr>
<td>Building of Complete Constructions or Parts</td>
<td>3.73%</td>
<td>0.31%</td>
<td>0.20%</td>
<td>-0.02</td>
</tr>
<tr>
<td>Building Installation &amp; Completion</td>
<td>1.64%</td>
<td>0.33%</td>
<td>0.24%</td>
<td>-0.08</td>
</tr>
<tr>
<td>Sales, Maintenance &amp; Repair of Motor Vehicles</td>
<td>1.24%</td>
<td>0.52%</td>
<td>0.20%</td>
<td>-0.06</td>
</tr>
<tr>
<td>Wholesale &amp; Commission Trade</td>
<td>3.11%</td>
<td>2.35%</td>
<td>1.10%</td>
<td>0.12</td>
</tr>
<tr>
<td>Retail Trade &amp; Repair of Household Goods</td>
<td>2.63%</td>
<td>0.28%</td>
<td>0.15%</td>
<td>-0.12</td>
</tr>
<tr>
<td>Transport</td>
<td>7.14%</td>
<td>1.78%</td>
<td>1.11%</td>
<td>0.02</td>
</tr>
<tr>
<td>Communication</td>
<td>0.60%</td>
<td>0.05%</td>
<td>0.02%</td>
<td>0.24</td>
</tr>
<tr>
<td>Average Across Industries</td>
<td>32.55%</td>
<td>63.88%</td>
<td>4.26</td>
<td></td>
</tr>
</tbody>
</table>

*Notes.* Mean of all industries in the year 2000. Relative Mean Log Wage is the industry’s mean log wage minus the employment weighted average log wage across all industries. Source: LIAB, Version 2, Year 2000.

12As independent variables of the wage estimation we used age, sex, education, nationality, region, industry, number of days in establishment, and a simplified skill level (un- or semi-skilled; skilled; highly qualified; manager). The latter is built from the Blossfeld (1985) skill classification, which categorizes the employer’s stated occupational 3-digit code of each employee into 12 groups.

13The quality of the education variable has been improved by the Fitzenberger et al. (2006) routine which mainly relies on extrapolation of past and future information in order to cope with missing and presumable invalid observations.
<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue (in Million Euros)</td>
<td>43.774</td>
<td>46.166</td>
<td>47.166</td>
<td>49.193</td>
<td>55.087</td>
<td>71.177</td>
<td>61.341</td>
<td>65.478</td>
<td>69.773</td>
<td>55.858</td>
</tr>
<tr>
<td>Wage (All)</td>
<td>76.853</td>
<td>76.880</td>
<td>78.949</td>
<td>79.610</td>
<td>80.469</td>
<td>82.117</td>
<td>82.553</td>
<td>82.631</td>
<td>82.290</td>
<td>80.137</td>
</tr>
<tr>
<td>Wage (Un- or Semi-Skilled)</td>
<td>70.543</td>
<td>70.569</td>
<td>72.316</td>
<td>72.757</td>
<td>73.497</td>
<td>75.211</td>
<td>75.371</td>
<td>75.505</td>
<td>75.307</td>
<td>73.347</td>
</tr>
<tr>
<td>Wage (Skilled)</td>
<td>78.170</td>
<td>78.091</td>
<td>80.237</td>
<td>80.727</td>
<td>81.728</td>
<td>83.365</td>
<td>84.056</td>
<td>84.204</td>
<td>84.380</td>
<td>81.515</td>
</tr>
<tr>
<td>Wage (Highly Qualified)</td>
<td>115.658</td>
<td>116.108</td>
<td>120.385</td>
<td>122.379</td>
<td>123.288</td>
<td>126.151</td>
<td>127.358</td>
<td>128.647</td>
<td>128.374</td>
<td>122.812</td>
</tr>
<tr>
<td>All Workers</td>
<td>170.499</td>
<td>170.236</td>
<td>164.268</td>
<td>159.48</td>
<td>170.48</td>
<td>181.06</td>
<td>165.914</td>
<td>158.389</td>
<td>169.197</td>
<td>167.769</td>
</tr>
<tr>
<td>Un- or Semi-Skilled Workers</td>
<td>78.161</td>
<td>76.595</td>
<td>72.823</td>
<td>69.815</td>
<td>74.885</td>
<td>78.026</td>
<td>69.985</td>
<td>65.564</td>
<td>70.438</td>
<td>73.004</td>
</tr>
<tr>
<td>Skilled Workers</td>
<td>62.257</td>
<td>62.888</td>
<td>60.080</td>
<td>58.963</td>
<td>62.420</td>
<td>67.006</td>
<td>63.458</td>
<td>59.762</td>
<td>63.508</td>
<td>62.235</td>
</tr>
<tr>
<td>Highly Qualified Workers</td>
<td>30.081</td>
<td>30.763</td>
<td>31.906</td>
<td>30.702</td>
<td>33.179</td>
<td>36.029</td>
<td>32.471</td>
<td>33.063</td>
<td>35.251</td>
<td>32.531</td>
</tr>
<tr>
<td>Collective Agreement</td>
<td>0.826</td>
<td>0.824</td>
<td>0.815</td>
<td>0.808</td>
<td>0.781</td>
<td>0.801</td>
<td>0.775</td>
<td>0.764</td>
<td>0.753</td>
<td>0.794</td>
</tr>
<tr>
<td>Age</td>
<td>40.744</td>
<td>40.855</td>
<td>41.185</td>
<td>41.549</td>
<td>41.821</td>
<td>42.045</td>
<td>42.276</td>
<td>42.486</td>
<td>42.604</td>
<td>41.730</td>
</tr>
<tr>
<td>Number of Firms</td>
<td>5.733</td>
<td>6.205</td>
<td>5.847</td>
<td>5.650</td>
<td>5.547</td>
<td>5.438</td>
<td>5.123</td>
<td>5.201</td>
<td>5.116</td>
<td>4.9860</td>
</tr>
<tr>
<td>Number of Workers</td>
<td>977.473</td>
<td>1056.317</td>
<td>960.475</td>
<td>901.063</td>
<td>945.675</td>
<td>984.604</td>
<td>849.977</td>
<td>823.781</td>
<td>865.614</td>
<td>8364.979</td>
</tr>
</tbody>
</table>

*Notes.* Unweighted mean over all firms by year. Standard deviation in brackets. One observation is one firm in one year. Source: LIAB, Version 2, Years 2000-2008.
year, and each of the three skill levels (un- or semi-skilled; skilled; highly qualified) the average daily gross wage. These are further deflated by the Consumer Price Index, with 2000 as the base year. See Table I for the relative log mean wage in each industry in the year 2000. The variables are then matched with the firm’s export statement in the annual survey, which ultimately leads to a data set of nearly 50,000 observations, corresponding to over 8.3 million worker-years, while one observation is one firm in one year. Summary statistics for all firms in the data set used can be found in Table II.

4 Empirical Results

We now want to assess the model’s predictions that a higher share of exports leads to a higher revenue, a higher average wage, and a higher measure of workers hired.

As in the Melitz (2003) model we assume constant firm productivity \( \varphi \) over the years, which means in return that changes in the share of exports can only be caused by either changes in the foreign and domestic demand shifters \( A_{x,c} \) and \( A_{d} \), respectively, or in trading costs \( \tau \). We claim that in the years from 2000 to 2008 especially the latter of the two events occurred. Thus, the enlargement of the European Union in May 2004, along with previously established bilateral trade agreements, considerably facilitated German exports into Eastern European countries, allowing German exports to the 10 new members to increase from 2004 to 2008 by about 70%, while overall exports to the rest of the world only increased by about 31%\(^\text{14} \) at the same time.

Since the model states that firm revenue, wages, and the measure of workers hired are driven by the firm’s share of exports, \( \sum_{c=1}^{C} y_{x,c}/y_{d} \), a variable not available in the data set, we have to find a reliable proxy for the ensuing empirical analysis. For this purpose, we divide a firm’s total turnover by its domestic share of total turnover, which leads with (3) to

\[
\frac{r}{r_{d}} = 1 + \frac{\sum_{c=1}^{C} r_{x,c}}{r_{d}} = 1 + \sum_{c=1}^{C} \tau_{c}^{-\rho} \frac{A_{x,c}}{A_{d}} \left( \frac{y_{x,c}}{y_{d}} \right)^{\rho} \equiv \Upsilon_{P}.
\]

Note the close relation to

\[
\Upsilon = 1 + \sum_{c=1}^{C} \frac{y_{x,c}}{y_{d}} = 1 + \sum_{c=1}^{C} \tau_{c}^{-\rho} \left( \frac{A_{x,c}}{A_{d}} \right)^{\frac{\rho}{1-\rho}}.
\]

As can be seen a decrease in trading costs \( \tau_{c} \) as well as an increase in the foreign demand shifter \( A_{x,c} \) will increase both \( \Upsilon \) and \( \Upsilon_{P} \). Though the proportions of the changes might be in both cases different and dependent on \( \rho \), our proxy \( \Upsilon_{P} \) nevertheless presents very similar features as the firm’s share of exports. While \( \Upsilon_{P} \) is more suitable to capture any changes in the intensive margin of exports, an export indicator variable,

\[
\mathbb{I} = \begin{cases} 
1 & \text{if } \Upsilon_{P} > 1 \\
0 & \text{if } \Upsilon_{P} = 1
\end{cases},
\]

\(^{14}\)Data obtained from Destatis.
is perceptive to changes in the extensive margin. By allowing for both the commonly used binary export status of a firm as well as its share of total turnover due to exports, we can in particular examine if the extension to a multiple country model is of any additional predictive value when trying to estimate certain characteristics of exporting firms. Since Υ as well as Υ\textsubscript{P} are not defined for firms that do not produce for the domestic market — which is in accordance with one of the basic assumptions of the model — we include a dummy variable to represent those firms in the panel that export 100% of their total output and categorize them with firms that export 99%. Note that overall results would not change, if these 174 firm-years were dropped from the panel.

4.1 Revenue

In the following, we try to assess the effect of the share of exports — or to be more precise, the share of revenue due to exports — on firm revenue. By taking the logarithm of (6), we obtain the specification of our fixed effects estimating equation

\[ \ln r\subscript{kst} = \beta_0 \ln r\subscript{d,st} + \beta_1 \ln \left( \frac{\varphi\subscript{kst}}{\varphi\subscript{d,st}} \right) + \beta_2 \ln \Upsilon\subscript{P,kst} + \beta_3 \Pi\subscript{kst} + \psi_s + \xi_t + u\subscript{kst}, \]

where \( t \) indexes years; \( \psi_s \) is an industry fixed effect, i.e. the intercept of each industry; \( \xi_t \) are time fixed effects; and \( u\subscript{kst} \) denotes the stochastic error. Note that \( \beta_1 \) corresponds to \( \rho \Gamma \) and \( \beta_2 \) to \( 1 - \rho \Gamma \). However, since we assume constant firm productivity \( \varphi \) over time, the coefficient for \( \beta_1 \) cannot be captured in our estimation.

Table III reports the coefficients for \( \beta_2 \) and \( \beta_3 \) (FE 1). First of all, the mere fact of becoming an exporting firm will, on average, increase the total revenue by 107%, a number consistent with other literature, see e.g. Verhoogen (2008). As predicted by the model, the share of exports — even while in the presence of the binary export status — does have a clear positive effect on revenue. For a notion of our results, we consider a firm that makes 10% of their total revenue abroad, i.e. \( \sum_{c=1}^{c^*} r_{x,c} / r = 0.1 \). Now a 1% increase in this share — thereby reducing \( r_d / r \) from 90% to 89% — would lead to a 1.124% increase in \( \Upsilon_P \) and therefore to a 0.916% increase in total revenue. An effect of considerable magnitude, keeping the rather small increase in the export revenue ratio in mind. As far as the coefficient of the industry’s zero profit revenue, \( \beta_0 \), is concerned, we can see that though being significant it is nonetheless of very small importance.

Next, we include some firm specific controls into our analysis. Though collective bargaining plays a minor role in the US, it is of huge importance in many European Countries. While according to Venn (2009) a mere 13% of all employees worked under a collective agreement in the US, in Germany the coverage rate was 63%\textsuperscript{15} in 2009. Though in recent years this figure is on its way down, the overall importance of collective bargaining appears to be still quite large. There are two further different kinds of collective

\textsuperscript{15}The difference to the data in Table II stems from the fact that our panel does not include service-oriented industries.
agreements in Germany: industry-wide company agreements and internal company agreements. The latter plays a minor role and is in most cases just a way for companies to participate in industry-wide company agreements without having to become a member of the industry’s employers’ association. Most importantly, note that collective bargaining agreements are always on the firm level such that all outcomes apply to all workers of the company, irrespective of whether they are a member of the union or not. We therefore extend our main estimating equation to a dummy variable that is 1 if a firm is subject to any of these two collective agreements and 0 if otherwise. As one can see, these agreements tend to have a large positive effect on revenue, whereas the share of unskilled workers as well as the average age of its work force appear to be of no importance. Even

\[
\begin{align*}
\text{TABLE III} \\
\text{Regression of Revenue on Share of Exports with and without Firm Specific Controls} \\
\hline
& \text{Dep. var.: Log Revenue (ln } r) \\
& \text{(FE 1)} \quad \text{(FE 2)} \\
\text{Zero Profit Revenue (ln } r_d) & 0.0535^{**} & 0.0425^{**} \\
& (0.0213) \quad (0.0196) \\
\text{Share of Exports (ln } \gamma_P) & 0.8155^{***} & 0.6869^{***} \\
& (0.0822) \quad (0.0662) \\
\text{Binary Export Status (I)} & 1.0704^{***} & 1.0441^{***} \\
& (0.1863) \quad (0.1589) \\
\text{Controls:} \\
\text{Collective Agreement} & 1.0903^{***} & \\
& (0.1176) \\
\text{Share Unskilled Workers} & 0.1501 & \\
& (0.2602) \\
\text{Age} & 0.0031 & \\
& (0.0147) \\
\text{N.obs.} & 44490 & 44490 \\
\text{R}^2 & 0.1512 & 0.2445 \\
\hline
\end{align*}
\]

Notes. An observation in the regression is one firm in one year. All regressions include 9 year and 25 industry dummies as well as a dummy variable for firms with an export share of a 100% (not reported). We report clustered standard errors at the industry level in brackets. Since not all firms stated their annual revenue, the N.obs. are smaller than in the ensuing empirical analyses on wage and measure of workers hired. Nevertheless, the mean of the share of exports (12.5524) and its standard deviation (22.5751) of this subsample only differ slightly from the full sample. Source: LIAB, Version 2, Years 2000-2008.

*** indicates significance at 1% level, ** at 5% level, * at 10% level.
though this extension to firm specific controls slightly decreases the effect of the share of exports (FE 2), the coefficient stays highly significant.

4.2 Wages

In order to measure the effect of a firm’s share of exports on its average wage, we use two different kinds of wages for each year-skill category as dependent variable: the overall average firm wage as well as the firm fixed wage component.

4.2.1 Overall Average Firm Wage

For the first part of the analysis, we take in analogy to the previous subsection the logarithm of (10) and obtain

$$\ln w_{kst} = \beta_0 \ln w_{d,st} + \beta_1 \ln \left( \frac{\varphi_{kst}}{\varphi_{d,st}} \right) + \beta_2 \ln Y_{P,kst} + \beta_3 I_{kst} + \psi + \xi_t + u_{kst}.$$  

For each of the three different skill categories: un- or semi-skilled, skilled, and highly qualified\(^\text{16}\) denoted by \(\ell\), we then run fixed effects regressions using the overall average firm wage in each skill-year category as dependent variable. Since not all firms do employ workers with all three kinds of skill levels, the number of observations differs for each of these estimations.

Table IV.A reports the coefficients \(\beta_2\) and \(\beta_3\) for all three different wage categories (FE 1, FE 3, FE 5). As can be seen, all three average wages are positively driven by the share of exports and the binary export status. For a notion of the export share’s coefficient, we again consider a firm whose share of revenue due to exports increases from 10\% to 11\%, i.e. a 1.124\% increase in \(Y_P\). According to our estimates of FE 1, this firm would then see the average wage paid to its un- or semi-skilled employees rise by 0.114\%. While this effect is of a far smaller magnitude than the previously established rise in revenue, the outcome of the bargaining game — where workers will get \(\rho_\gamma/(1 + \rho_\gamma)\) while the firm keeps \(1/(1 + \rho_\gamma)\) of the revenue — is in accordance with these figures. The coefficient of the industry’s lowest wage, \(\beta_0\), is again very small and only significant in the case of the average wage of skilled workers.

We further control for firm specific variables (FE 2, FE 4, FE 6). As expected, in all cases participation in a collective agreement appears to have a large positive effect on wages. In addition, a higher share of unskilled workers significantly drives down wages for un- or semi-skilled workers. As one might think, age, though not significant, positively drives wages. Though the coefficients of interest are robust to the controls, they all decrease in magnitude.

\(^\text{16}\)In order to have enough observations in each industry-skill-year, we do not consider separately managers and hence categorize them with highly qualified workers.
4.2.2 Firm Level Wage Component

As these results could be driven by worker specific characteristics as well as assortative matching between high-wage firms and high-wage workers, we decompose individual worker wages into its components and use the firm fixed wage component as dependent variable. We thereby rely strongly on the methods presented in Helpman et al. (2013) and Akerman et al. (2013).

To this end, we first estimate the following OLS Mincer regression separately for each industry-skill-year:

$$\ln w_{is\ell t} = z_{is\ell t}' \lambda_{s\ell t} + \eta_{k\ell t} + \nu_{istt},$$

where $w_{is\ell t}$ is a worker $i$’s wage, in industry $s$, with a skill level of $\ell$, in a given year $t$. The vector $z_{is\ell t}'$ denotes individual observable worker characteristics, while $\lambda_{s\ell t}$ captures the returns to these characteristics. $\eta_{k\ell t}$ is the fixed effect of firm $k$ and $\nu_{istt}$ the stochastic error. Our specification for observable worker characteristics is as follows: education (using categories for: no degree at all; vocational training or high school degree; vocational training and high school degree; technical college degree; university degree; as well as missing values), age (using the categories: 19-24; 25-29; 30-39; 40-49; 50-65; 66+), and gender. Due to possible idiosyncrasies of very small businesses, we only use those workers with at least four colleagues in the same firm-skill-year category. Since the regression is estimated separately for each industry-skill-year, the coefficients on worker characteristics as well as the firm fixed effects can vary over time and across skill levels. The firm fixed effects are further normalized to sum to zero for each industry-skill-year, whereby the regressions’ intercepts are absorbed by the observable worker characteristics components.

We then estimate in analogy to the above specification the following fixed effects specification

$$\hat{\eta}_{k\ell t} = \beta_0 \hat{\eta}_{d,s\ell t} + \beta_1 \ln \left( \frac{\varphi_{k\ell t}}{\varphi_{d,s\ell t}} \right) + \beta_2 \ln \Upsilon_{p,k\ell t} + \beta_3 \mathbb{1}_{k\ell t} + \psi_{s} + \xi_{t} + u_{k\ell t},$$

where $\hat{\eta}_{d,s\ell t}$ denotes the industry’s lowest firm low wage component. Results are reported in Table IV.B. As can be seen, all coefficients of interest are significant and of the same magnitude as in the overall average firm wage case, while being robust to controls for collective agreements. As the share of exports appears to be mainly driven by the firm level component of wages, the model’s predictions are borne out to a large degree.
### TABLE IV
Regression of Wage on Share of Exports with and without Firm Specific Controls

<table>
<thead>
<tr>
<th></th>
<th>A. Dep. var.: Average Log Wage (ln $w$)</th>
<th>B. Dep. var.: Firm Log Wage Component ($\eta$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>un- or semi-skilled (FE 1)</td>
<td>skilled (FE 3)</td>
</tr>
<tr>
<td></td>
<td>(FE 2)</td>
<td>(FE 4)</td>
</tr>
<tr>
<td>Lowest Wage (ln $w_d$)</td>
<td>0.0171</td>
<td>0.0043</td>
</tr>
<tr>
<td></td>
<td>(0.0121)</td>
<td>(0.0149)</td>
</tr>
<tr>
<td>Share of Exports (ln $\Upsilon_P$)</td>
<td>0.1013***</td>
<td>0.0715***</td>
</tr>
<tr>
<td></td>
<td>(0.0124)</td>
<td>(0.0087)</td>
</tr>
<tr>
<td>Binary Export Status (I)</td>
<td>0.0903***</td>
<td>0.0892***</td>
</tr>
<tr>
<td></td>
<td>(0.0287)</td>
<td>(0.0258)</td>
</tr>
<tr>
<td>Controls:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collective Agreement</td>
<td>0.2258***</td>
<td>0.2228***</td>
</tr>
<tr>
<td></td>
<td>(0.0151)</td>
<td>(0.0155)</td>
</tr>
<tr>
<td>Share Unskilled Workers</td>
<td>-0.1700***</td>
<td>-0.0038</td>
</tr>
<tr>
<td></td>
<td>(0.0393)</td>
<td>(0.0362)</td>
</tr>
<tr>
<td>Age</td>
<td>0.0026</td>
<td>0.0029</td>
</tr>
<tr>
<td></td>
<td>(0.0020)</td>
<td>(0.0021)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.0567</td>
<td>0.2076</td>
</tr>
</tbody>
</table>

|                           | un- or semi-skilled (FE 3) | skilled (FE 5) | highly qualified (FE 7) |
|                           | (FE 4) | (FE 6) | (FE 8) |
| Lowest Wage (ln $\tilde{w}_d$) | 0.1152*** | 0.1132*** | 0.0375 | 0.0383 | 0.0701*** | 0.0712*** |
|                           | (0.0303) | (0.0384) | (0.0345) | (0.0304) | (0.0205) | (0.0168) |
| Share of Exports (ln $\Upsilon_P$) | 0.0939*** | 0.0677*** | 0.1110*** | 0.0897*** | 0.0913*** | 0.0733*** |
|                           | (0.0120) | (0.0099) | (0.0119) | (0.0092) | (0.0102) | (0.0091) |
| Binary Export Status (I)  | 0.0690*** | 0.0675*** | 0.1113*** | 0.1134*** | 0.0662** | 0.0708** |
|                           | (0.0247) | (0.0228) | (0.0549) | (0.0180) | (0.0247) | (0.0212) |
| Controls:                 |                                  |                                              |
| Collective Agreement      | 0.2284*** | 0.2034*** | 0.2030*** |
|                           | (0.0151) | (0.0163) | (0.0150) |
| N.obs.                    | 35,527 | 35,527 | 38,164 | 38,164 | 20,474 | 20,474 |
| $R^2$                     | 0.0492 | 0.2066 | 0.0919 | 0.2173 | 0.0702 | 0.1929 |

**Notes.** An observation in the regression is one firm in one year. All regressions include 9 year and 25 industry dummies as well as a dummy variable for firms with an export share of a 100% (not reported). We report clustered standard errors at the industry level in brackets. N.obs. differ, for not every firm employs workers of all three kinds of skill levels. Source: LIAB, Version 2, Years 2000-2008.

*** indicates significance at 1% level, ** at 5% level, * at 10% level.
4.3 Measure of Workers Hired

While we have seen that firms with a higher share of exports do not only have a higher revenue but also pay higher wages to their employees, we now try to give an answer to the question, if they — as the model suggests — also employ more workers. Using the logarithm on (11), we obtain

\[
\ln h_{kst} = \beta_0 \ln h_{d,st} + \beta_1 \ln \left( \frac{\varphi_{kst}}{\varphi_{d,st}} \right) + \beta_2 \ln \Upsilon_{P,kst} + \beta_3 I_{kst} + \psi_s + \xi_t + u_{kst}.
\]

We then use two different kinds of observations for the measure of workers hired: the reported and the matched number of workers. Since the data stems from annual voluntary surveys of a sample of firms which is then matched with data from all workers liable to social security, there is on the one hand the stated number of workers in a firm (reported) while there is also the actual number of matched workers (matched). Now these two vari-

| TABLE V |
|------------------|------------------|------------------|------------------|------------------|
| **Regression of Measure of Workers Hired on Share of Exports with and without Firm Specific Controls** |
| Dep. var.: Log Measure of Workers Hired (ln h) | reported | matched |
| (FE 1) | (FE 2) | (FE 3) | (FE 4) |
| Lowest Measure of Workers Hired (ln h_d) | 0.0054 | -0.0003 | 0.6383* | 0.6121* |
| | (0.0310) | (0.0312) | (0.3681) | (0.3518) |
| Share of Exports (ln \Upsilon_P) | 0.5329*** | 0.4367*** | 0.5530*** | 0.4625*** |
| | (0.0819) | (0.0671) | (0.0807) | (0.0676) |
| Binary Export Status (I) | 0.7324*** | 0.6964*** | 0.7662*** | 0.7378*** |
| | (0.1259) | (0.1042) | (0.1410) | (0.1146) |
| Controls: | | | | |
| Collective Agreement | 0.8429*** | 0.8314*** |
| | (0.0923) | (0.0989) |
| Share Unskilled Workers | 0.5251*** | 0.4099** |
| | (0.0858) | (0.1564) |
| Age | -0.0016 | 0.0031 |
| | (0.0107) | (0.0112) |
| N.obs. | 49860 | 49847 | 49860 | 49860 |
| R^2 | 0.1112 | 0.2095 | 0.1182 | 0.2091 |

**Notes.** An observation in the regression is one firm in one year. All regressions include 9 year and 25 industry dummies as well as a dummy variable for firms with an export share of a 100% (not reported). N.obs. differ in FE 2 since not all companies reported their share of unskilled workers. We report clustered standard errors at the industry level in brackets. Source: LIAB, Version 2, Years 2000-2008.

*** indicates significance at 1% level, ** at 5% level, * at 10% level.
ables slightly differ in some cases for various reasons. For example the reported number of workers contains both workers in part-time employment and dormant employment relationships. These are workers we initially tried to exclude from our sample by introducing a wage threshold. However, since we cannot be perfectly sure that our sample reflects an accurate image of a firm’s actual full-time work force, for we might have excluded too few or too many workers, the use of the reported number of workers is not only a way to ensure more reliable results but also gives us an additional control for our previous estimations.

As predicted by the model, the measure of workers hired is in both cases positively driven by the share of exports. Now again, an increase from 10% to 11% in the firm’s share of revenue due to exports would go along with a 0.599% (FE 1) or a 0.621% (FE 3) increase in the measure of workers hired. With an average reported measure of workers of 167 this effect is quite large considering the relatively small increase in the share of exports.

While collective agreements have a positive influence, the average age of a firm appears to have no effect at all. In accordance with the reported measure of workers hired, we use the reported share of unskilled workers as a control in FE 2. Though this variable is better suited as a control than the observed share of unskilled workers for it also contains workers in part-time employment, we are suspicious that its accuracy has suffered due to the fact that firms had to decide by themselves if a worker’s task requires him or her to be unskilled or skilled.

Nevertheless, both measures produce very similar results, a fact that assures us that the created data set of full-time workers accurately represents each industry’s work force.

5 Conclusion

By expanding the Melitz (2003) model to a world with asymmetric countries and therefore to a world with different aggregate demand shifters, we can explain for firms to export to a varying number of countries, all depending on their initial productivity, trading costs, and the countries’ export thresholds. Since this setting enables firms to have a continuum of export shares instead of the commonly used binary export status in the model, a link to the HIR framework, ultimately allows for a model that predicts a higher revenue, higher average wages as well as a higher measure of workers hired on account of an increasing share of exports. While assuming that the productivity drawn by a firm stays constant over time, its export status can still be subject to variation through changes in the countries’ demand shifters or in trading costs.

We further use the LIAB, a German linked employer-employee data set, in order to empirically corroborate the predictions of our model. Since the LIAB doesn’t provide the share of products sold abroad as required in the model, we take the share of total turnover due to exports as a proxy variable. Using then fixed effects regressions, we are able to
show that all three measures are positively driven by the share of revenue due to exports while being robust to a set of firm specific controls. The coefficients of the effects are in all cases of a considerable magnitude, while acting in accordance with the model’s parameter limitations. Our results do not only give further empirical support to a relatively new line of research of trade models with labor market frictions, but also show that allowing for a continuous export status gives valuable information when predicting the effects of trade liberalization or foreign demand shifts on domestic firms.
References


Online Appendix

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The Impact of a Firm’s Share of Exports on Revenue, Wages, and Measure of Workers Hired

— Theory and Evidence

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A Mathematical Derivations

Domestic demand $y_d$ and revenue $r_d$

The preferences of a representative consumer are given by a C.E.S. utility function over a continuum of goods indexed by $\omega$:

$$ U = \left[ \int_{\omega \in \Omega} y(\omega)^{\rho} \, d\omega \right]^{\frac{1}{\rho}}, $$

where the measure of the set $\Omega$ represents the mass of available goods within the sector $U$. These goods are substitutes, implying $0 < \rho < 1$ and an elasticity of substitution between any two goods of

$$ \sigma = \frac{1}{1 - \rho} > 1 \iff \rho = 1 - \frac{1}{\sigma} = \frac{\sigma - 1}{\sigma}. $$

The consumer’s constrained maximization problem may be solved by the Lagrangian

$$ \mathcal{L} = U^\rho - \lambda \left( \int_{\omega \in \Omega} p(\omega)y(\omega) \, d\omega - I \right), $$

where $U^\rho$ is a strictly increasing transformation of $U$ and $I$ the consumer’s income. Which yields the following first-order condition

$$ \frac{\partial \mathcal{L}}{\partial y(\omega)} = \rho y(\omega)^{\rho - 1} - \lambda p(\omega) = 0. $$

By dividing the first-order condition of one variety $\omega_1$ by the first-order condition of another variety $\omega_2$ we obtain relative demand

$$ \frac{y(\omega_1)}{y(\omega_2)} = \left( \frac{p(\omega_1)}{p(\omega_2)} \right)^{\frac{1}{\rho - 1}}. $$
Multiply both sides with \( y(\omega_2) \) yields

\[
y(\omega_1) = y(\omega_2) \left( \frac{p(\omega_1)}{p(\omega_2)} \right)^{-\sigma}.
\]

By multiplying both sides with \( p(\omega_1) \) and taking the integral with respect to \( \omega_1 \) we get

\[
\int_{\omega \in \Omega} p(\omega_1) y(\omega_1) d\omega_1 = \int_{\omega \in \Omega} y(\omega_2) p(\omega_1)^{1-\sigma} p(\omega_2)^{\sigma} d\omega_1.
\]

On the left-hand side we now have the consumer’s total expenditure on all varieties \( R \), which is equal to his income \( I \), i.e.

\[
R = I = y(\omega_2) p(\omega_2)^{\sigma} \int_{\omega \in \Omega} p(\omega_1)^{1-\sigma} d\omega_1.
\]

Solving for \( y(\omega_2) \) yields the Marshallian demand for \( \omega_2 \)

\[
y(\omega_2) = \frac{I p(\omega_2)^{-\sigma}}{\int_{\omega \in \Omega} p(\omega_1)^{1-\sigma} d\omega_1}.
\]

Let the aggregate price be given by

\[
P = \left[ \int_{\omega \in \Omega} p(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}},
\]

Marshallian demand is equal to

\[
y(\omega) = p(\omega)^{-\sigma} P^{\sigma-1} I = \left( \frac{p(\omega)}{P} \right)^{-\sigma} \frac{I}{P}.
\]

With domestic output \( y_d(\omega) \) being equal to \( y(\omega) \) for non-exporting firms, domestic firm revenue can then be written as

\[
r_d(\omega) = y_d(\omega) \cdot p(\omega) = I \left( \frac{p(\omega)}{P} \right)^{1-\sigma},
\]

where \( I_d \) and \( P_d \) indicate domestic income and the domestic aggregate price, respectively.

Note that with \( p_d(\omega) = y_d(\omega)^{1-\frac{1}{\rho}} I_d^{\frac{1}{\rho}} P_d^{\frac{\sigma-1}{\rho}} \) domestic revenue can also be written as in HIR, i.e.

\[
r_d(\omega) = y_d(\omega)^{1-\frac{1}{\rho}} I_d^{\frac{1}{\rho}} P_d^{\frac{\sigma-1}{\rho}} = y_d(\omega)^{\rho} I_d^{1-\rho} P_d^\rho = y_d(\omega)^\rho A_d,
\]

where \( A_d \) is called the domestic demand shifter.

**Link between \( A_d \) and \( \tilde{\phi}_t \)**

We can link the demand shifter \( A_d \) to the total average productivity \( \tilde{\phi}_t \) as defined in Melitz (2003), p. 1710, by using equation (17) and (18) from ibid.: 

\[
A_d = R^{1-\rho} P^\rho = (M_t \bar{\rho})^{1-\rho} \left( M_t^{\frac{1}{\rho}} \frac{w(\tilde{\phi}_t)}{\tilde{\phi}_t} \right)^\rho = \bar{\tilde{\rho}}^{1-\rho} \left( \frac{w(\tilde{\phi}_t)}{\tilde{\phi}_t \bar{\rho}} \right)^\rho.
\]
\( \Upsilon \) and a derivation of \( y_d(\varphi) = y(\varphi)/\Upsilon \)

Using (4) we can write

\[
y(\varphi) = y_d(\varphi) + y_{x,1}(\varphi) + \ldots + y_{x,c}(\varphi)
\]
as

\[
y(\varphi) = y_d(\varphi) + \tau_1^{\rho} y_d(\varphi) \left( \frac{A_{x,1}}{A_d} \right)^{\frac{\rho}{\rho - \gamma}} + \ldots + \tau_c^{\rho} y_d(\varphi) \left( \frac{A_{x,c}}{A_d} \right)^{\frac{\rho}{\rho - \gamma}}
\]

By defining \( \Upsilon = 1 + \tau_1^{\rho} \left( \frac{A_{x,1}}{A_d} \right)^{\frac{\rho}{\rho - \gamma}} + \ldots + \tau_c^{\rho} \left( \frac{A_{x,c}}{A_d} \right)^{\frac{\rho}{\rho - \gamma}} \) we obtain

\[
y_d(\varphi) = y(\varphi)/\Upsilon.
\]

A firm’s total revenue \( r \)

\[
r(\varphi) = y_d(\varphi)^{\rho} A_d + \tau_1^{\rho} y_{x,1}(\varphi)^{\rho} A_{x,1} + \ldots + \tau_c^{\rho} y_{x,c}(\varphi)^{\rho} A_{x,c}
\]

using the first-order conditions (4) this can be written as

\[
= y_d(\varphi)^{\rho} A_d + \tau_1^{\rho} y_d(\varphi)^{\rho} A_{x,1} \left( \frac{A_{x,1}}{A_d} \right)^{\frac{\rho}{\rho - \gamma}} + \ldots + \tau_c^{\rho} y_d(\varphi)^{\rho} A_{x,c} \left( \frac{A_{x,c}}{A_d} \right)^{\frac{\rho}{\rho - \gamma}}
\]

\[
= y_d(\varphi)^{\rho} A_d \left( 1 + \tau_1^{\rho} \left( \frac{A_{x,1}}{A_d} \right)^{\frac{\rho}{\rho - \gamma}} + \ldots + \tau_c^{\rho} \left( \frac{A_{x,c}}{A_d} \right)^{\frac{\rho}{\rho - \gamma}} \right)^{1 - \rho}.
\]

Revenue as a function of a firm’s productivity

Using the earlier definition of \( r(\varphi) \) in (3), the production function, and the first-order conditions (7) and (8), we are now able to express revenue as

\[
r(\varphi) = \Upsilon(\varphi)^{\frac{1}{1 - \rho}} A_d^\Gamma \left( \frac{\rho \gamma}{\rho(1 - \gamma) \zeta} \right)^\rho \left( \frac{\rho \gamma}{\rho(1 - \gamma) \zeta} \right)^{-\frac{\rho}{\rho - \gamma}} \Upsilon^\Gamma,
\]

where \( \Gamma = 1 - \rho \gamma - \rho(1 - \gamma \zeta)/\delta \). In the next step we compute the firm’s profits by making once more use of the first-order conditions

\[
\pi(\varphi) = \frac{\Gamma}{1 + \rho \gamma} r(\varphi) - f_d - \sum_{c=1}^{c'} f_{x,c}.
\]
Furthermore we know that the firm with the lowest productivity $\varphi_d$ makes exactly zero profits (and is not exporting). Thence it follows\(^{17}\)

\[
\frac{\Gamma}{1 + \rho\gamma} r(\varphi_d) = f_d \quad \Rightarrow \quad r(\varphi_d) \equiv r_d = \frac{1 + \rho\gamma}{\Gamma} f_d. \tag{A.3}
\]

In the following, we use the expression for $r(\varphi)$ from (A.2) and determine the relative revenue of a firm in comparison to the firm with the lowest productivity $\varphi_d$:

\[
\frac{r(\varphi)}{r_d} = \frac{1}{1 + \rho\gamma} \left( \frac{\varphi}{\varphi_d} \right)^{\frac{\gamma}{\Gamma}} \quad \Rightarrow \quad r(\varphi) = r_d \cdot \left( \frac{\varphi}{\varphi_d} \right)^{\frac{\gamma}{\Gamma}}. \tag{A.4}
\]

**Wage as a function of a firm’s productivity**

By the same token we are able to compute $a_e(\varphi)$. We again employ the first-order conditions (7) and (8) and get

\[
a_e(\varphi)^\frac{\delta}{\delta(\varphi)} = \frac{\gamma}{\Gamma} \left( \frac{\varphi}{\varphi_d} \right)^{\frac{\gamma}{\Gamma}} \quad \Rightarrow \quad a_e(\varphi) = a_e(\varphi_d) \left( \frac{\varphi}{\varphi_d} \right)^{\frac{\gamma}{\Gamma}}. \tag{A.4}
\]

Using (A.3) with the first-order conditions and (8), we can compute

\[
a_e(\varphi_d) = \left( \frac{\rho(1 - \gamma k - 1 + \rho\gamma)}{\Gamma} f_d \right)^{\frac{1}{\frac{\gamma}{\Gamma}}} = \left( \frac{\rho(1 - \gamma \varphi_d)}{\Gamma} f_d \right)^{\frac{1}{\frac{\gamma}{\Gamma}}}. \]

With the wage condition from (9), the lowest wage paid by a domestic firm is then

\[
w(\varphi_d) \equiv w_d = b \left( \frac{a_e(\varphi_d)}{a_{\text{min}}} \right)^{\frac{\gamma}{\Gamma}} = \left( \frac{\rho(1 - \gamma \varphi_d)}{\Gamma a_{\text{min}}} f_d \right)^{\frac{\gamma}{\Gamma}}.
\]

This yields a wage relation that is solely dependent on $\varphi$, $\Upsilon(\varphi)$, $\varphi_d$, $b$, and parameters:

\[
\frac{w(\varphi)}{w_d} = \left( \frac{a_e(\varphi)}{a_e(\varphi_d)} \right)^{\frac{\gamma}{\Gamma}} = \Upsilon \left( \frac{\varphi}{\varphi_d} \right)^{\frac{\gamma}{\Gamma}} \Rightarrow \quad w(\varphi) = w_d \cdot \left( \frac{\varphi}{\varphi_d} \right)^{\frac{\gamma}{\Gamma}} \cdot \Upsilon \left( \frac{\varphi}{\varphi_d} \right)^{\frac{\gamma}{\Gamma}}.
\]

As can be seen from this last equation, wages increase with firm productivity and are always higher for exporting firms than for non-exporting firms.

**Measure of workers hired as a function of a firm’s productivity**

By the same token, we can derive the lowest measure of workers hired

\[
h(\varphi_d) \equiv h_d = m(\varphi_d) \left( \frac{a_{\text{min},d}}{a_e(\varphi_d)} \right)^{\frac{\gamma}{\Gamma}} = \frac{\rho\gamma}{1 + \rho\gamma} r_d \left( \frac{a_{\text{min},d}}{a_e(\varphi_d)} \right)^{\frac{\gamma}{\Gamma}}.
\]

Using (A.4) and (6), the relation to $h(\varphi)$ is then given by

\[
h(\varphi) = r(\varphi) \left( \frac{a_e(\varphi_d)}{a_e(\varphi)} \right)^{\frac{\gamma}{\Gamma}} = \left( \frac{\varphi}{\varphi_d} \right)^{\frac{\gamma}{\Gamma}} \Upsilon \left( \frac{\varphi_d}{\varphi_d} \right)^{\frac{\gamma}{\Gamma}} = \Upsilon \left( \frac{\varphi}{\varphi_d} \right)^{\frac{\gamma}{\Gamma}} \cdot \left( \frac{\varphi_d}{\varphi_d} \right)^{\frac{\gamma}{\Gamma}}.
\]

\(^{17}\)Note, while $r_d(\varphi)$ is the domestic revenue for a firm with productivity $\varphi$, $r_d$ is the revenue of a non-exporting firm with zero profits.
Which ultimality leads to

$$h(\varphi) = h_d \cdot \left( \frac{\varphi}{\varphi_d} \right)^{\rho \left( 1 - \frac{\varphi_d}{\rho} \right)} \cdot \Gamma \left( 1 - \rho \left( 1 - \zeta_d / \delta \right) \right).$$