Explaining the Size Differences of Exporter Productivity Premia: Theory and Evidence

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Abstract

Why is it that exporter productivity premia (EPP) differ so widely in size? We take this question to the theory and to the data. First, we compute the sectoral EPP in a standard heterogeneous firms trade model. This gives novel predictions: a larger variance in the productivity distribution and larger trade costs (both fixed and variable) increase a sector's EPP, while the effect stemming from the intra-sectoral elasticity of substitution (i.e. product differentiation) is ambiguous. Second, based on 13 years of data for all Danish manufacturing firms, we confirm the role of fixed trade costs and find that sectors with lower elasticity of substitution command larger EPPs. Most importantly, we establish that the variance in the underlying productivity distribution, i.e. the degree of firm heterogeneity in a sector, is decisive for the magnitude of a sector's EPP. These findings imply substantial room for refinements when conducting empirical research into exporter performance.

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1 Introduction

The stylized fact of positive exporter productivity premia (EPP) – and the elegant new theories that came along with it (e.g. Melitz, 2003) – have intrigued empirical and theoretical researchers in international economics; see Greenaway and Kneller (2007), Wagner (2007, 2012), Redding (2011) and Bernard et al. (2012) for surveys. Despite the impressive volume of analyses, a central question remains open. Why is it that exporter productivity premia vary so widely in size across countries and across industries? Empirically, productivity premia range, for example in Europe, from 7 (0) percent in Sweden to 58 (10) percent in Belgium for identical pooled (fixed effects) estimation specifications on comparable data (ISGEP, 2008, table 4). On the sectoral level – the focus of the present paper – the issue is even more pronounced. For Denmark total factor productivity (TFP) based fixed effects EPP estimates across 99 sectors span from -16% to +445%. On first sight, theory is silent on such size differences and empirical research has produced such results largely uncommented.

To be fair, short of classifying EPP differences in magnitude simply as idiosyncratic characteristics of sectors or differences in econometric estimation strategies, a large number of renown papers that report sectoral EPP differences have addressed the issue by conducting additional empirical investigation, for example by splitting samples according to firm size or age and by providing plausible rationalizations; see e.g. Aw and Hwang (1995), Aw et al. (2000), Farinas and Martin-Marcos (2007), Head and Ries (2003), or Merino (2004).[1] The current paper takes a different direction. We explore the explicit link between the existing heterogeneous firms trade theory and the empirical patterns of EPP magnitude. Obviously, the best theory can hope, is to identify some fundamental mechanisms that are broadly in line with the empirical evidence. Any claim that some specific theory is the only possible explanation of an empirical phenomenon is conceptually flawed. Similarly, we should not expect the theory to fit data perfectly either. Still, by taking the Melitz (2003) model and seeing what light it can shed on the empirical regularity of cross-sectoral EPP size differences, we are able to document that heterogeneous firms theory contains sensible predictions on fundamental drivers of EPP size, but also that there are additional empirical regularities not captured by the new workhorse model.

[1] Similarly, ISGEP (2008) establishes and discusses intensively the identified size differences between country EPPs – in contrast much of the remaining literature are single country studies (see the surveys of Greenaway and Kneller, 2007; Wagner, 2007, 2012; and Bernard et al., 2012). In particular, the implementation of different estimation strategies makes comparisons across studies difficult.

First, we turn to theory. A simple thought experiment illustrates the task. Consider a standard heterogenous firms trade model and add one extremely productive exporting firm. At first sight, this should increase the EPP. Yet, empirical EPP measures compare the group of exporters to non-exporters. Thus, in theory, via general equilibrium effects, the addition of a highly productive firm toughens the exit and exporter cut-off and therefore changes the composition of firms in both groups. Hence, it becomes a non-trivial task to compute the overall effect on the EPP. Accordingly, we start out by computing the theoretical sectoral EPP in a symmetric two-country multi-sector version of a Melitz (2003) model with Pareto distributed productivities. In contrast, previous theoretical work has simply considered the rankings of firms according to productivity. Such ranking implies that firms above the export threshold export and firms below do not export. While a positive sign for the EPP follows directly from this exercise, inference on the drivers of EPP magnitude is not easily provided. We resolve these issues and present predictions from theory addressing the relation of exogenous (and empirically measurable) variables to the sectoral EPP. Theory predicts that a larger degree of heterogeneity in the productivity distribution of a sector and higher trade costs (both fixed and variable) imply a larger sectoral EPP.[2] Furthermore, the model shows that smaller home fixed costs correlate positively with the sector's EPP, while the effects from the intra-sector elasticity of substitution (i.e. product differentiation) are ambiguous.

Previous theoretical work by Schröder and Sørensen (2012) has investigated observable exporter productivity (in contrast to marginal productivity), both in a Melitz (2003) setting as well as in a Bernard et al. (2003) model. In their work, Schröder and Sørensen (2012) already note that the underlying distribution of marginal productivities must matter for the sign and size of the aggregated EPP. Yet, their main focus is on individual firms' observable productivity. In contrast, the present paper computes a comprehensive theoretical equivalent of sectoral EPP and examines how this measure responds to changes in all the different parameters of the model.

Second, we take the predictions of the theory to the data. Based on 13 years of firm-level data for the universe of Danish firms, including destination and product codes, we are able to implement estimations of sectoral EPPs for 3-digit level industries. We confirm the role and effect of fixed trade costs: sectors with higher fixed export costs feature larger EPPs. In contrast, the theoretical prediction for variable trade costs is not confirmed by

[2]That the dispersion of the productivity distribution is one of the important fundamentals is already pointed out by Helpman et al. (2004) in the context of export channel choices, i.e. their investigation of the relation between direct exports and foreign affiliate sales in various destination markets.

our data. Most importantly, we establish that the variance in the underlying productivity distribution is decisive for the size of EPP realizations: sectors with a larger degree of heterogeneity display larger magnitudes of EPP. Furthermore, market power, that is a lower elasticity of substitution (or more differentiated products) – which in theory has ambiguous effects – is in the data associated with larger EPPs.

These findings imply substantial room for refinements when conducting empirical research into exporter performance. For example,when assessing EPP by pooling firms across different industries, as commonly done in the literature, parametric and non-parametric estimates will be affected by the underlying industry structure. Similarly, comparisons of EPPs across time are potentially problematic if a changing industry composition with respect to, for instance, the degree of productivity heterogeneity is ignored. Furthermore, even though the present paper focuses on sectoral EPPs, the question of cross-country differences remains unanswered. Our theoretical and empirical results provide some guidance for future research based on cross-country data sets. Our findings show that one strategy for explaining cross-country EPP differences might be to utilize the cross-country differences in industry structure in general and the degree of firm heterogeneity in particular, which could easily be assessed from the available export and industry data.

The remainder of the paper is structured as follows. Section 2 introduces and calculates the sectoral EPP in a two-country symmetric multi-sector Melitz (2003) model augmented with Pareto distributed productivities. Section 3 presents our data and empirical setup. Section 4 presents our empirical results and compares them to the theory. Section 5 concludes.

2 Exporter Productivity Premia in Theory

We derive exporter productivity premia in a symmetric two-country version of Melitz (2003). We make only two modifications. First, in order to reflect cross-sectoral variation in EPP we rewrite the model to include J heterogeneous sectors. This extension is only a matter of exposition. Second, to ensure tractability and transparency and to obtain clear-cut predictions on how the EPP depends on industry-specific characteristics we adopt the conventional assumption of productivities being Pareto distributed.[3]

[3]For applications of the Pareto distribution within heterogeneous firm trade models, see e.g. Helpman et al. (2004) and Chaney (2008). Moreover, the Pareto approximates the distribution of productivity of firms found in empirical work (see e.g. Simon and Bonini, 1958; and more recently Axtell, 2001; and Luttmer, 2007) and resembles the empirical patterns we find for Danish firms at least for the right tail of the distribution, see Figure

2.1 Households

A representative household supplies L units of labor inelastically to the labor market and derives utility from consumption of different varieties from the J sectors. The utility function of the household reads

$$U = u\left(C_1, C_2, .., C_J\right),$$

where C_j denotes the consumption of the sector j specific composite consumption bundle.[4] The composite consumption bundles are of the Dixit-Stiglitz (1977) CES type

$$C_j = \left(\int_{\omega \in \Omega_j} \left(c_j\left(\omega\right)\right)^{\frac{\sigma_j - 1}{\sigma_j}}\right)^{\frac{\sigma_j}{\sigma_j - 1}} \quad \text{for } j = 1, 2, .., J\ , \tag{1}$$

where $c_j(\omega)$ denotes consumption of variety ω of sector j, Ω_j is the endogenously determined set of varieties (both domestic and foreign) from sector j available to the household and σ_j is the elasticity of substitution between any two varieties within sector j. Demand for variety ω of sector j becomes

$$c_j\left(\omega\right) = C_j \left(\frac{p_j\left(\omega\right)}{P_j}\right)^{-\sigma_j} \quad \text{for } j = 1, 2, .., J \text{ and } \forall\ \omega \in \Omega_j\ , \tag{2}$$

where $p_j(\omega)$ is the price of variety ω of sector j and P_j is the price of buying one unit of the composite bundle C_j.[5]

2.2 Firms

All J sectors feature monopolistic competition. Accordingly, firms take the sector level variables C_j and P_j as given. Each firm only produces one unique variety ω within a single sector. Labor is the only input factor and remunerated at the economy wide wage rate w. Entry into a sector, i.e. inventing a new variety, is associated with sunk costs of $f_{e,j}$ units of labor. The creation

1 and Table 1.

[4]We assume that all first-order partial derivatives are positive, i.e. utility increases in all the sector-specific consumption bundles (defined by (1)).

[5]The price index reads

$$P_j = \left(\int_{\omega \in \Omega_j} \left(p_j\left(\omega\right)\right)^{1-\sigma_j}\right)^{\frac{1}{1-\sigma_j}} \quad \text{for } j = 1, 2, .., J\ .$$

of a new variety entails a variety-specific and fixed productivity, $\varphi_j(\omega)$. Realized productivity is stochastic due to the random nature of research and development (R&D) processes. We assume that productivities are drawn from sector-specific known Pareto distributions with location parameters $\varphi_{0,j}$ and shape parameters k_j.[6] The cumulative density functions thus read

$$G_j(\varphi_j(\omega)) = 1 - \left(\frac{\varphi_j(\omega)}{\varphi_{0,j}}\right)^{-k_j} \quad \text{for } j = 1, 2, .., J\ . \tag{3}$$

Firms that decide to produce face fixed costs of production f_j. Accordingly, the labor requirement of a firm with productivity $\varphi_j(\omega)$ that produces q units becomes $l_j(q|\, \varphi_j(\omega)) = \frac{q}{\varphi_j(\omega)} + f_j$. In addition, firms have the option to export. Exporting is subject to fixed export costs of $f_{j,x}$ units of labor and variable export costs of the iceberg type, i.e. firms must ship τ_j units for one unit to arrive.

Given the constant elasticity of demand, cf. (2), firms in each sector set prices as constant mark-ups on marginal costs implying that domestic (subscript d) and export market (subscript x) prices are given by

$$\begin{aligned} p_{j,d}(\varphi_j(\omega)) &= \frac{\sigma_j}{\sigma_j - 1}\frac{w}{\varphi_j(\omega)} \\ p_{j,x}(\varphi_j(\omega)) &= \frac{\sigma_j}{\sigma_j - 1}\frac{w\tau_j}{\varphi_j(\omega)}\ . \end{aligned}$$

Accordingly, reduced form profits in the domestic market and in the export market of a sector are given by

$$\begin{aligned} \pi_{j,d}(\varphi_j(\omega)) &= B_j(\varphi_j(\omega))^{\sigma_j - 1} - wf_j \\ \pi_{j,x}(\varphi_j(\omega)) &= B_j(\varphi_j(\omega))^{\sigma_j - 1}\tau_j^{1-\sigma_j} - wf_{j,x} \end{aligned}$$

where $B_j \equiv C_j(P_j)^{\sigma_j}\left(\frac{\sigma_j}{\sigma_j - 1}\right)^{-\sigma_j}\frac{1}{\sigma_j - 1}(w)^{1-\sigma_j}$ is a sector-specific demand component. It follows that profits increase in productivity $\varphi_j(\omega)$ and only firms with sufficiently high productivity find it profitable to enter a given market. Consequently, firms self-select according to productivity into exiters ($\varphi_j(\omega) < \varphi^*_{j,d}(\omega)$), pure domestic non-exporters ($\varphi^*_{j,d}(\omega) \leq \varphi_j(\omega) < \varphi^*_{j,x}(\omega)$) and exporters ($\varphi_j(\omega) \geq \varphi^*_{j,x}(\omega)$) where the exit thresholds, $\varphi^*_{j,d}(\omega)$,

[6] We impose the parameter restriction $k_j > max(2, \sigma_j - 1)$ in order to have finite variance of the productivity distribution.

and export thresholds of a sector $(\varphi^*_{j,x}(\omega))$ are defined by

$$\pi_{j,d}\left(\varphi^*_{j,d}(\omega)\right) = 0 \Leftrightarrow \varphi^*_{j,d}(\omega) = \left(\frac{wf_j}{B_j}\right)^{\frac{1}{\sigma_j-1}} \tag{4}$$

$$\pi_{j,x}\left(\varphi^*_{j,x}(\omega)\right) = 0 \Leftrightarrow \varphi^*_{j,x}(\omega) = \left(\frac{wf_{j,x}\tau_j^{\sigma_j-1}}{B_j}\right)^{\frac{1}{\sigma_j-1}} . \tag{5}$$

We impose the parameter restriction $f_{j,x}\tau_j^{\sigma_j-1} > f_j$ which ensures that firms – in line with empirical evidence – partition into exporters and non-exporters.

2.3 Theoretical EPP Predictions

Within the above specification we are able to compute sectoral EPPs. In particular, we derive the theoretical EPP measure that corresponds to empirical measures, namely, comparing the difference in average productivity between the group of exporters and the group of non-exporters relative to the average productivity of the group of non-exporters. Given CES consumption bundles a sector's structure – and accordingly the sectoral EPP – only depends on the specific variables for the sector in question and not on the equilibrium values of all B_j for $j = 1, 2, .., J$. The EPP in sector j reads:

$$PR_j \equiv \frac{E\left(\varphi_j(\omega)\middle|\, \varphi_j(\omega) \geq \varphi^*_{j,x}\right) - E\left(\varphi_j(\omega)\middle|\, \varphi^*_{j,d} \leq \varphi_j(\omega) < \varphi^*_{j,x}\right)}{E\left(\varphi_j(\omega)\middle|\, \varphi^*_{j,d} \leq \varphi_j(\omega) < \varphi^*_{j,x}\right)} . \tag{6}$$

By using the Pareto distribution given in (3), one can rewrite (6) as

$$PR_j = \frac{\left(\frac{\varphi^*_j}{\varphi^*_{x,j}}\right)^{-k_j} - 1}{\left(\frac{\varphi^*_j}{\varphi^*_{x,j}}\right)^{-k_j+1} - 1} - 1 . \tag{7}$$

We can now state:

Proposition 1. *The theoretical equivalent of the empirical measure of the exporter productivity premium, PR_j, in sector j depends only on the sector variables $k_j, f_{j,x}, \tau_j, f_j$ and σ_j and is given by*

$$PR_j = \frac{\left(\frac{f_{j,x}\tau_j^{\sigma_j-1}}{f_j}\right)^{\frac{k_j}{\sigma_j-1}} - 1}{\left(\frac{f_{j,x}\tau_j^{\sigma_j-1}}{f_j}\right)^{\frac{k_j-1}{\sigma_j-1}} - 1} - 1 . \tag{8}$$

Proof. The premium follows from evaluating (7) using the thresholds given by (4) and (5). □

Proposition 1 implies a series of results on how the various sector variables affect the magnitude of a sector's EPP.[7]

Corollary 1. *Sectors that are more heterogeneous in their productivity distribution (lower k_j, implying a higher productivity dispersion) have larger exporter productivity premia.*

Corollary 2. *Sectors that have higher fixed costs of exporting ($f_{j,x}$) have larger exporter productivity premia.*

Corollary 3. *Sectors that have higher variable trade costs (τ_j) have larger exporter productivity premia.*

Corollary 4. *Sectors that have lower fixed costs of production (f_j) have larger exporter productivity premia.*

Corollary 5. *The effect of the intra-sectoral elasticity of substitution (σ_j) on the exporter productivity premia is ambiguous.*

Corollaries 1 to 4 provide clear and potentially testable predictions on the drivers of EPP size differences. Obviously, the assumptions on the distribution function of productivity are important for these results. To illustrate: consider the effect of fixed export costs on the premium (Corollary 2). As is well known from the Melitz (2003) model, higher fixed export costs reduce the domestic exit threshold and increase the export threshold. The lower exit threshold ceteris paribus reduces average productivity among non-exporters and thus increases the premium as more low-productive pure domestic firms appear in the sector. The higher export threshold has two opposing effects. On the one hand, it increases average productivity among exporters and thus the EPP should increase. On the other hand, at the same time it increases average productivity among non-exporters as the least productive exporters shift status and become non-exporters, this implies a reduction in the EPP. Thus in general no clear-cut results are to be expected unless some structure on the productivity distribution is assumed. The Pareto distribution is particularly convenient in this respect, not just because we find some empirical support for its applicability to our firm-level data (see Figure 1 and Table 1), but also because its highly trackable properties imply that the EPP becomes

[7]The proofs of the Corollaries follow directly from the partial derivatives of the expression for the sector-specific productivity premium (8).

a function of only two independent arguments, namely the ratio of the export threshold to the exit threshold and the shape parameter of the Pareto, cf. equation (7). Following from this, it should be noted that the effect on the attractiveness of the export market relative to the domestic market underlies the results of Corollaries 2, 3 and 4.

To understand Corollary 1, note that the degree of heterogeneity increases (higher productivity dispersion) when the right tail of the distribution has more mass (lower k_j). More mass in the tail in turn increases the density among highly productive firms – both exporters and non-exporters. However, the effect is less pronounced for non-exporters because their productivity distribution, unlike that of exporters, is right truncated. Hence, the EPP increases with the degree of heterogeneity.

Finally, our findings on the drivers of EPP size differences – even though cast in a multi-sector interpretation – translate to cross-country EPP size differences. In a multi-country model, for example, a country with a more homogenous productivity distribution would display a lower EPP compared to countries with more heterogeneity among their firms.

3 Data and Empirical Estimation Strategy

In line with the theoretical foundation outlined in Section 2, our empirical focus lies on sectoral EPPs.[8] As always when taking theory to the data, it is important to acknowledge the wide range of forces that affect real countries and firms' trading patterns, but that have been conveniently ignored in the theoretical setup. For example, alternative drivers of trade, such as comparative advantage or effects stemming from other country asymmetries, are all absent in our theoretical EPP results, but will matter in the data. Furthermore, time and timing – an illusive concept when studying steady state equilibria – will clearly be present in our firm-level data. Also, importer status – absent in the theory – clearly matters in reality and must be controlled for in our estimations (see Bernard et al. 2007, 2012). Finally, as Eaton et al. (2012) have pointed out recently, the conventional modeling of firms as points on a continuum creates additional – potentially costly – discrepancies between theory and data.

Still, taking the workhorse model of heterogeneous firms trade and seeing what light it can shed on the stylized fact of substantial cross-sectoral EPP size differences is a significant step forward and as such follows naturally

[8]An alternative research design could examine cross-country EPP variations, however, data collection and coding differ across countries, and even the comprehensive study of ISGEP (2008) arrives at only 14 comparable countries.

from the previous literature. Wagner (2007, 2012) provides comprehensive surveys of the empirical literature and finds almost universal support for the view that the substantial positive EPPs found in the literature are caused by the most productive firms self-selecting into export markets (for other recent studies see e.g., López, 2009; Kneller and Pisu, 2010; Vinzenzo and Wagner, 2011). In the same spirit, Bernard et al. (2007, p. 111) argue that: "Results from virtually every study across industries and countries confirm that high productivity precedes entry into export markets". At the same time, empirical support for the hypothesis that firms become more productive as a consequence of exporting is much weaker (see Kneller and Pisu, 2010, for a recent survey). Of course the two hypotheses, self-selection and learning through exports, are not mutually exclusive. Accordingly, we will evaluate whether our results are robust to potential reversed causality.

3.1 Data

Our data set consists of Danish firm-level data provided by Statistics Denmark for the period 1995-2007 and combines destination-specific export information with business account information. Starting from the universe of all Danish firms, we exclude non-manufacturing firms and firms with missing sales or total sales below DKK 100,000 (about USD 17,000). Thus, we only exclude extremely small if not erroneous firms but abstain from trimming the sample with respect to the number employees, output, productivity or other firm characteristics to maintain information on essentially all active manufacturing firms. The resulting sample is composed of 40,235 firms, of which 9,736 exporters sell to a total of 168 countries. The central variables capital and labor are measured as firms' total fixed assets and as firms' number of full-time equivalent employees, respectively.[9]

Sectoral information is calculated at the 3-digit level, giving us 99 sectors over 13 years with active exporters to compare and analyze sectoral EPP differences across. Furthermore, to quantify sectoral iceberg trade costs we estimate sectoral gravity models merging destination-specific data on GDP, GDP per capita, distance and bilateral indicators of physical, and political separation provided by Head et al. (2010) and extrapolated until 2007. Finally, we also use OECD maritime transport costs data.

To access how closely the productivity distribution for Denmark resembles a Pareto distribution, we transform equation (3) into logs and obtain a

[9]Part-time workers receive a weight of 0.5. To reduce potential selection bias due to item non-response, missing information on total fixed assets is recoded to zero and all models include an industry-specific indicator variable taking the value one if such recoding has been carried out.

convenient linear regression model that allows us to evaluate the goodness of fit of the Pareto distribution:

$$\ln \widehat{G}_j(\varphi_{ijt,TFP}) = \alpha + k_j \ln \varphi_{ijt,TFP} + \epsilon_{ijt} \qquad (9)$$

with $\widehat{G}_j(\varphi_{ijt,TFP})$ denoting the empirical distribution function of productivity in industry j, i denoting firm and t time.

Figure 1: **Productivity Distribution Pooled over all Industries**

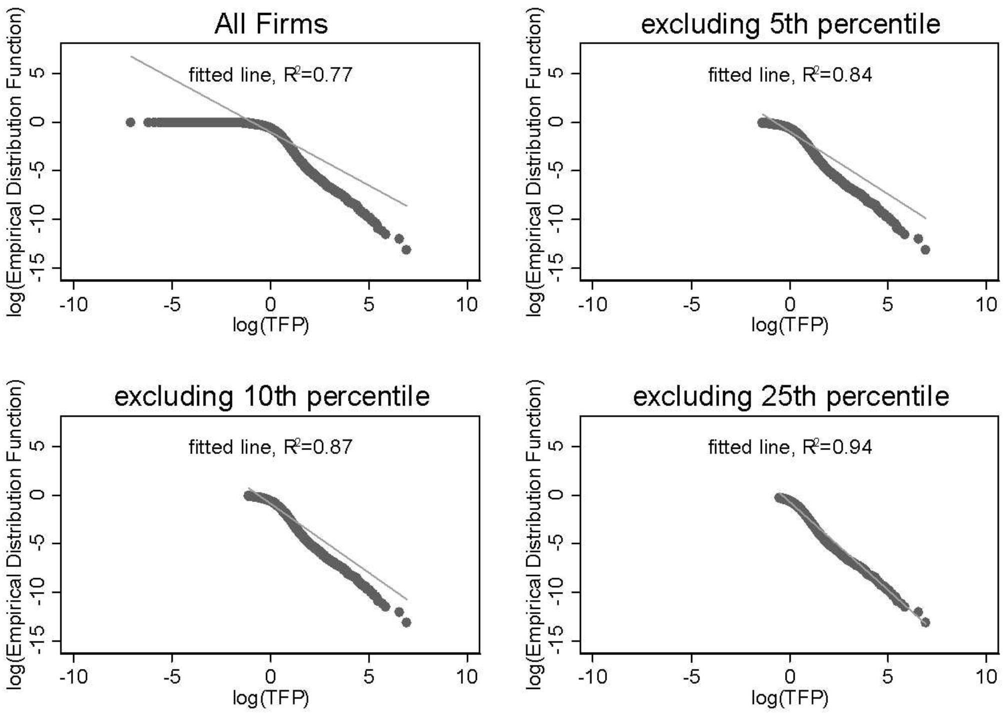

Figure 1 depicts plots of $\ln \widehat{G}(\varphi)$ against $\ln \varphi$ pooled over all industries, firms and years and the corresponding fitted lines and R^2s as goodness of fit measures with φ being constructed from TFP regressions.[10] If productivity indeed follows a Pareto distribution, the depicted log-log relationship should follow a linear function. As can be seen, a linear function provides a fairly poor fit when considering all firms. However, when ordering firms according to their productivity and subsequently excluding the bottom 5th, 10th and

[10]In contrast to our theoretical model that considers labor to be the only production factor, our empirical analysis allows for capital and intermediate inputs as additional production factors. Accordingly, our preferred productivity measure is total factor productivity.

25th percentile, the linear fit between $\ln \widehat{G}(\varphi)$ and $\ln \varphi$ improves dramatically. Thus – in line with previous literature – the right tail of the actual productivity distribution has the best match to the Pareto. We repeat this exercise and estimate per sector Pareto functions reporting on the spread in R^2's found among our 99 industries in Table 1. Again, by excluding the lowest productivity firms the R^2 values improve.

Table 1: **Fit of Pareto Distribution by Industry**

	Mean	Standard Deviation	Observations
R^2 All Firms	0.76	0.07	99
R^2 excluding 5th percentile	0.83	0.06	99
R^2 excluding 10th percentile	0.86	0.05	99
R^2 excluding 25th percentile	0.92	0.05	99

3.2 Empirical Model

To quantify the sectoral EPP, we estimate variants of the following baseline specification:

$$\begin{aligned} \ln Y_{it} &= \alpha_i + \beta_{cj} Cap_{it} + \beta_{lj} Lab_{it} + \zeta Imp_{it} \\ &+ \delta Exp_{it} + \eta V_{jt} + \theta(Exp_{it} V_{jt}) + Year_t + \epsilon_{it}, \end{aligned} \tag{10}$$

with Y_{it} representing value added of firm i at time t. Cap and Lab denote the input factors capital and labor for which we estimate separate elasticities β_{cj} and β_{lj} at the three-digit industry level j.[11] Following, from the findings presented in Bernard et al. (2007, 2012), we also include an indicator variable for importer status, Imp. Exporter status is represented by the dummy variable Exp while V_{jt} represents industry j specific characteristics as outlined in Section 2, such as the degree of heterogeneity in productivity among the firms in the industry with $i \in j$. Firm-specific unobserved characteristics

[11] Accordingly, our model is equivalent to a standard TFP regression that obtains log TFP from a first-stage production function estimation at the three-digit industry level. As many studies rely on simple labor productivity measures, we also, for completeness, evaluate the labor productivity premium of export status estimating the following model:

$$\ln\left(\frac{Y_{it}}{Lab_{it}}\right) = \alpha_i + \zeta Imp_{it} + \delta Exp_{it} + \eta V_{jt} + \theta(Exp_{it} V_{jt}) + Year_t + \epsilon_{it}.$$

are captured by α_i and are assumed to be constant over time. Including firm fixed effects in our main specification implies that the exporter productivity premium is identified through within-firm variation in export status combined with cross-section and time variation in industry characteristics reflected in the interaction term. Finally, $Year_t$ denotes a full set of time dummies capturing common time-specific shocks. The remaining error term ϵ_{it} is allowed to be heteroscedastic and contemporaneously correlated within industries.[12] As firms do not switch between industries in our data, we do not include industry fixed effects.

In order to test for the robustness of our findings, we proceed by estimating a Levinsohn-Petrin specification of the above model allowing for time-changing firm-specific shocks α_{it} (see Levinsohn and Petrin, 2003).[13]

To further test for the robustness of our findings, we also estimate a difference-in-difference specification of (10) that allows for firm-specific productivity trends that may determine selection into exporter status. Accordingly, in this specification we compare exporting firms to non-exporting firms that before their actual export spells were on the same productivity trajectory:

$$\begin{aligned} \triangle \ln Y_{it} &= \alpha_i + \beta_{cj}\triangle Cap_{it} + \beta_{lj}\triangle Lab_{it} + \zeta\triangle Imp_{it} \\ &+ \delta\triangle Exp_{it} + \eta\triangle V_{jt} + \theta\triangle(Exp_{it}V_{jt}) + \triangle Year_t + \triangle\epsilon_{it}. \end{aligned} \tag{11}$$

In order to rule out that our findings are driven by the previously discussed potential reversed causality, i.e. by learning through exporting instead of self-selection, we also estimate a variant of (10) using $\ln Y_{it-3}$ as the dependent variable.

According to the above models, the exporter productivity premium expressed in percent is:

$$PR_{jt} = \left(e^{\delta+\theta V_{jt}} - 1\right) * 100. \tag{12}$$

Hence, we allow the exporter productivity premium to vary according to industry characteristics V as predicted by theory. Obviously, our estimations serve to reflect upon the theory, and remain descriptive in nature since, in order to avoid multicolinearity, we do not control simultaneously for all considered industry characteristics.

In order to test Corollaries 1 to 5, we assess a number of sector characteristics.

[12]We allow for contemporaneous correlation at the 2-digit level nesting 3-digit industries.

[13]We opt for the Levinsohn-Petrin specification as opposed to the method introduced by Olley and Pakes (1996) to avoid selection bias on the basis of missing investments.

First, the degree of heterogeneity in the productivity distribution is measured by the industries standard deviation of log labor productivity.[14] Note that in our theoretical model – omitting subscript t in the remainder of the section – this measure reads

$$Std\left(\log \varphi_j(\omega) \middle| \varphi_j(\omega) \geq \varphi^*_{j,d}\right) = k_j^{-1} .$$

Accordingly, the relation between the empirical exporter productivity premia and productivity dispersion is directly comparable to Corollary 1, cf. (8), and we expect sectors with a higher degree of heterogeneity in productivity to command larger EPPs.

Next, we move to Corollaries 2 to 5. In contrast to our measure of k_j, directly observable empirical measures corresponding to $f_{j,x}, \tau_j, f_j$ and σ_j are somewhat less straightforward to obtain. We use the following proxies.

We capture sectoral fixed export costs, $f_{j,x}$, by (i) the per sector average of firms foreign sales volume ($\overline{S}_x$) – indicating minimum efficiency scale of the export activity. In our model this reads

$$\overline{S}_x = \int_{\varphi^*_{jX}}^{\infty} p_{j,x}(\varphi)\, C_j \left(\frac{p_{j,x}(\varphi)}{P_j}\right)^{-\sigma_j} \frac{dG_j(\varphi)}{1 - G_j\left(\varphi^*_{jX}\right)} = \frac{w\sigma_j k_j f_{j,x}}{k_j - (\sigma_j - 1)} ,$$

which is – in line with intuition – increasing in our variable of interest, $f_{j,x}$. Furthermore, we use (ii) the sector average of number of destinations served per firm as an alternative proxy for $f_{j,x}$ – with more destinations implying larger initial (destination-unspecific) fixed export costs. We expect to find a positive relation between our two measures and the sectoral EPP (Corollary 2).

We proxy variable iceberg trade costs, τ_j, by (i) the average share of foreign sales in total sales of exporters in an industry. According to the model a larger share stems from lower variable trade costs. To see this, note that at the firm level we have export sales in total sales given by

$$\frac{p_{j,x}(\varphi)\, C_j \left(\frac{p_{j,x}(\varphi)}{P_j}\right)^{-\sigma_j}}{p_{j,d}(\varphi)\, C_j \left(\frac{p_{j,d}(\varphi)}{P_j}\right)^{-\sigma_j}} = \tau_j^{1-\sigma_j} .$$

In addition, we provide (ii) a gravity-based estimation of sectoral transport costs. The data allows us to estimate separate gravity equations at the

[14] Technically, we could also use an estimated shape parameter k_j directly. However, since the data only in part resemble a Pareto distribution, the standard deviation measure is more appropriate. It allows us to use the entire universe of firms, instead of omitting the lowest productivity firms, in order to increase the Pareto-ness of the productivity distribution (see Table 1).

three-digit industry level and we stipulate that sectors with lower gravity coefficients – i.e. less responsive to distance – have lower trade costs.[15] As yet another measure of iceberg trade costs we (iii) obtain ad-valorem trade costs for manufactured goods from the OECD maritime transport costs data base at the two-digit level of the harmonized system focusing on container shipments and we obtain three-digit industry-level transport cost measures by weighting with firms' respective export values. Naturally, maritime transport cost measures can only reflect export costs for sea transport and thus disregard air fright and trade costs within Europe. Nevertheless, we use the measure to test for the robustness of our findings. According to Corollary 3 higher variable trade costs should result in larger EPP.

We represent the fixed costs of production, f_j, by (i) the capital intensity of domestic firms measured as the value of fixed assets over output. Moreover, we use (ii) the sectoral average of firms' domestic sales ($\overline{S}_d$); whereby a larger scale indicates larger fixed costs. Parallel to $\overline{S}_x$ from above, this is in the model

$$\overline{S}_d = \int_{\varphi_j^*}^{\infty} p_{j,d}(\varphi) C_j \left(\frac{p_{j,d}(\varphi)}{P_j} \right)^{-\sigma_j} \frac{dG_j(\varphi)}{1 - G_j(\varphi_j^*)} = \frac{\sigma_j k_j w f_j}{k_j - (\sigma_j - 1)},$$

which is increasing in f_j. In terms of a theoretical prediction we expect that higher fixed costs of production are associated with a lower sectoral EPP (Corollary 4).

Finally, although the theory was ambiguous on the effect of σ_j on the EPP, we look for empirical regularities in the data. We use a method of moments based estimate of the elasticity of substitution, thus estimating the σ_j's from the data. We exploit the variance in the sales volume of firm in their domestic market (both exporters and non-exporters) that is found in the data. Taking the model at face value when $r_j(\varphi) = B_j \varphi^{\sigma_{j,t}-1}$ denotes sales on the domestic market, we can compute the coefficient of variation of domestic market sales in a sector as

$$CV\left(r_j(\varphi) \middle| \varphi > \varphi_j^*\right) = \frac{\sigma_j - 1}{\sqrt{k_j(k_j - 2(\sigma_j - 1))}},$$

which allows us to calculate σ_j only depending on the shape parameter k_j and the sectoral coefficient of variation, both of which we estimate from the data.[16]

[15] We follow Silva and Tenreyro (2006) and estimate Poisson pseudo-maximum-likelihood gravity models. Our model controls for partner country GDP and GDP per capita, firm size, distance, common currency, regional trade agreements, destination country WTO membership, and common border.

[16] Our derivation of σ is elaborated further in a separate appendix, available upon request.

4 Results

Table 2 presents the estimated EPPs applying the previously outlined estimation techniques.[17] According to equation (12) the EPP is allowed to differ along 3-digit industry characteristics V. For this reason we present EPPs calculated at the mean, the bottom decile, the median, and the top decile of the respective industry measure V and perform a Wald test on the H_0 that the EPPs for the top and bottom decile are equal.[18]

First, focussing on the estimates regarding industry-level productivity heterogeneity reported in Panel (1) of Table 2 we find the pattern predicted by Corollary 1. For instance, applying our baseline TFP model (10) we find that in industries where firms are most homogenous in terms of productivity, exporting firms experience a productivity premium of 12 percent. In contrast, in the industries with the highest productivity heterogeneity exporter status yields productivity premia of 29 percent. Importantly, this pattern is robust to the used estimation technique. Irrespective of whether we base our estimates on simple labor productivity measures, a Levinsohn-Petrin model specification accounting for firm- and time-specific shocks, or the difference-in-difference model from equation (11), EPPs monotonously increase with industry-level productivity heterogeneity.

Second, in line with Corollary 2 we generally find EPPs to monotonously increase with fixed export costs captured by the industry-specific average size of foreign sales and the average number of export destinations. As reported in panel (2) of Table 2, when focusing on the TFP estimates, the average EPP differential between firms in industries with the highest and industries with the lowest fixed costs of exporting is more than 17 percentage points. Again, the identified pattern is largely robust to the estimation technique - only when applying the Levinsohn-Petrin estimator the identified difference in EPPs is statistically not significant which may be due to the substantially reduced sample size in that specification.

Third, when considering variable trade costs, irrespective of the used proxy, we find some evidence that EPPs are the higher the smaller the variable trade costs are, thus going counter to Corollary 3. However, as becomes

[17]The same goes for Tables 3 and 4. Thus in what follows we only report the estimated EPPs, but we do not report the 60 underlying econometric estimations that generate the EPPs in Tables 2, 3 and 4.

[18]Note that the available number of observations varies with the different estimation techniques. Furthermore, due to item non-response with respect to V, the models vary slightly in the number of observations. Since the focus of this exercise is on the patterns outlined in Corollaries 1 to 5, we do not restrict the sample to be common across all analyzed dimensions of V.

apparent in Panel (3) of Table 2, the pattern is not very strong. EPP differences between the top and bottom deciles of our iceberg trade costs proxies are weakly statistically significant for one measure in our main TFP specification but not robust to the chosen estimation technique. Accordingly, our empirical evidence presented here on Corollary 3 is inconclusive.

Fourth, when analyzing the fixed costs of production using our capital intensity and production scale based proxies, we only find inconclusive results, see Panel (4) of Table 2. While our baseline TFP model yields statistically significant positive EPP differences between the top and bottom decile of fixed production costs thereby apparently contradicting Corollary 4, the respective difference is statistically insignificant when applying the simple labor productivity, Diff-in-Diff or Levinsohn-Petrin estimator. Furthermore, our proxies for fixed production costs are highly correlated with our proxy for fixed export costs. Thus, it is likely that in the empirical model both detrimental effects, that of fixed export and fixed production costs, are captured and cancel out.

Fifth, regarding our estimates on the elasticity of substitution results are reported in Panel (5) of Table 2. While Corollary 5 had an ambiguous prediction, the data displays some strong patterns for the elasticity of substitution in a sector irrespective of the applied estimation technique. In particular, sectors with lower elasticity of substitution command higher EPPs. Put differently, the further away a sector is from the perfect competition benchmark, the larger is the EPP. For instance, when focusing on our TFP estimates, export activities in industries in the top decile of σ are associated with an EPP of only 11 percent while the EPP in the bottom decile of σ is 29 percent.[19]

4.1 Robustness Checks

We proceed by testing for the robustness of our findings with respect to the definition of an exporting firm. As an alternative we only classify firms as exporters that export in the current year and in the immediate previous and subsequent year $(t, t-1, t+1)$. Thus, we condition on exporting being a longer term activity. Naturally, we loose the first and last observation for each firm, which considerably reduces the overall sample size. Table 3 re-

[19] This role of the intra-sectoral elasticity of substitution raises the question if other industry structure measures could be underlying drivers of the EPP. We have accordingly checked the most common measure, namely the Herfindahl industry concentration measure. The Herfindahl index in the theoretical model is given by $H_j = \frac{1}{M_j}\left(1 + \frac{(\sigma_j - 1)^2}{k_j(k_j - 2(\sigma_j - 1))}\right)$, where M_j is the mass of domestic firms. Thus the theoretical equivalent of the Herfindahl index has an ambiguous relation to the EPP in (8). Similarly, our empirical tests found no response of the EPP to sectoral industry concentration.

ports the respective findings for our main TFP specification. Overall, EPPs are smaller than the ones reported in Table 2. However, after re-estimating our baseline model including the standard exporter definition but the sample from Table 3, thus omitting the first and last observation for each firm, we can confirm that this is driven by the reduced sample size. Furthermore, the patterns with respect to EPP magnitude along the various industry characteristics are very similar to our previous findings for the main TFP specification. The only exception are the findings on variable iceberg trade costs, where EPP differences between top and bottom deciles now never are statistically significant. However, since iceberg costs related results were sensitive to the used estimation technique, we already argued that the empirical evidence on Corollary 3 is inconclusive. Thus, we can confirm our main findings on Corollary 1 to Corollary 5 for the alternative definition considering only longer term exporters.

Finally, we test whether our EPP estimates are robust to potential reversed causality, i.e. to the idea that the most productive firms do not select into exporting but become more productive through exporting. To do so we estimate Equation 10 with Y_{it-3} as the dependent variable as well as Cap_{it-3} and Lab_{it-3} among the explanatory variables, hence, we quantify EPPs prior to exporting thereby reducing potential simultaneity. This should also take care of any potential simultaneity between our industry-level aggregates V_{jt} and firm-level productivity. The respective EPP estimates are presented in Table 4. Most notably, although EPPs are overall smaller than in our previous regressions, we find patterns very similar to our main contemporaneous TFP specification.

5 Conclusion

Exporter productivity premia are a central stylized fact of international commerce, albeit the accumulated empirical evidence discloses substantial – and so far unexplained – EPP size differences between countries and across sectors within countries. The present paper tackles this issue both theoretically and empirically. First, we ask if at all – and in what direction – the workhorse model of heterogeneous firms trade (e.g. Melitz, 2003) contains predictions on the determinants of magnitude for exporter productivity premia. In particular, we introduce the theoretical equivalent of the empirical EPP measure into a version of the Melitz (2003) model. Second, we compare the theoretical predications to the evidence derived from Danish firm-level data, by estimating a range of empirical models commonly found in the literature. We are able to identify an important role for fixed trade costs and for the degree of heterogeneity in productivity in explaining the variance in EPP magnitude. Both theoretically and empirically, industries where the realized productivity distribution displays a wider variance feature larger EPPs; similarly, industries with higher fixed trade costs display larger EPPs. Moreover, while in theory the intra-sectoral elasticity of substitution (and hence the degree of product differentiation) has ambiguous effects on EPP magnitude, we find strong empirical patterns that sectors with lower elasticity of substitution command larger EPPs.

Setting our findings in perspective to the sizable empirical literature on exporter productivity premia, we highlight two directions in which the present paper contributes. Firstly, we are able to identify some central fundamentals that matter – and are robust to the various specifications tested. We establish that the variance in the underlying productivity distribution, the size of fixed export costs, and the intra-sectoral elasticity of substitution are decisive fundamentals for EPP realizations. Secondly, while it is obvious that larger EPPs are not synonymous with superior economic performance, our analysis suggests that the cross-country variation in EPPs observed in the literature can at least partly be explained by cross-country differences in industry structure and industry characteristics.

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Table 2: **Exporter Productivity Premium in percent**

	Corollary 1						
	Mean V	Bottom Decile V	Median V	Top Decile V	Wald-Test Top=Bottom	Obs.	Firms
	V ≡ Productivity Heterogeneity						
LaborProd.	13.15***	5.75***	11.61***	22.29***	F=34.56***	252366	40235
	1.27	1.89	1.33	1.87	p=0.000		
TFP	19.81***	12.46***	18.28***	28.83***	F=27.2***	252366	40235
	1.21	2.02	1.31	1.91	p=0.000		
TFP,Diff-in-Diff	6.19***	1.44	5.21***	11.91***	F=11.29***	207853	33717
	0.88	1.84	1.00	1.69	p=0.001		
Levinsohn-Petrin	14.28***	11.38***	13.64***	17.68***	F=5.44**	161700	23937
	1.22	2.09	1.37	1.43	p=0.030		

	Corollary 2						
	Mean V	Bottom Decile V	Median V	Top Decile V	Wald-Test Top=Bottom	Obs.	Firms
	i: V ≡Average size of foreign sales						
LaborProd.	13.56***	8.74***	13.86***	19.56***	F=4.07**	252204	40228
	1.28	2.79	1.26	3.14	p=0.046		
TFP	19.93***	12.16***	20.43***	29.88***	F=15.69***	252204	40228
	1.03	2.06	1.04	2.87	p=0.000		
TFP,Diff-in-Diff	6.30***	3.96***	6.45***	9.15***	F=8.68***	207695	33708
	0.71	0.90	0.72	1.35	p=0.004		
Levinsohn-Petrin	14.58***	12.61***	14.72***	16.82***	F=0.60	161624	23935
	1.09	3.16	1.02	2.59	p=0.446		
	ii:V≡Average number of export destinations						
LaborProd.	13.31***	7.31***	14.01	18.93***	F=8.39***	252245	40231
	1.28	2.53	1.27	2.22	p=0.005		
TFP	19.61***	9.87***	20.77***	29.01***	F=50.00***	252245	40231
	1.06	1.72	1.07	1.72	p=0.000		
TFP,Diff-in-Diff	6.39***	4.69***	6.58***	7.92***	F=4.90**	207720	33711
	0.71	0.83	0.74	1.16	p=0.029		
Levinsohn-Petrin	14.52***	11.47***	14.80***	17.05***	F=1.69	161645	23937
	1.11	3.04	1.02	1.71	p=0.207		

Notes: *, **, *** Statistically significant at the 10 percent, the 5 percent, the 1 percent level, respectively.

Table 2: **...continued**

	Corollary 3						
	Mean V	Bottom Decile V	Median V	Top Decile V	Wald-Test Top=Bottom	Obs.	Firms
			i: V ≡ Share of foreign sales of exporters				
Labor Prod.	13.80***	12.32***	13.79***	15.08***	F=2.45	252204	40228
	1.20	1.42	1.20	1.55	p=0.121		
TFP	20.34***	18.41***	20.34***	22.03***	F=2.92*	252204	40228
	1.16	1.73	1.16	1.41	p=0.090		
TFP,Diff-in-Diff	6.35***	5.78***	6.35***	6.85***	F=1.09	207695	33708
	0.75	0.84	0.75	0.96	p=0.298		
Levinsohn-Petrin	14.55***	13.30***	14.57***	15.58***	F=1.56	161624	23935
	1.14	1.80	1.13	1.08	p=0.226		
			ii: V≡Gravity model distance parameter				
Labor Prod.	13.76***	15.33***	14.09***	11.72***	F=0.54	228787	36312
	1.34	1.92	1.19	3.58	p=0.465		
TFP	19.99***	22.06***	20.42***	17.31***	F=0.93	228787	36312
	1.35	1.50	1.06	3.85	p=0.338		
TFP,Diff-in-Diff	6.39***	7.23***	6.57***	5.30***	F=0.79	188425	30390
	0.77	1.12	0.76	1.55	p=0.377		
Levinsohn-Petrin	14.02***	16.14***	14.43***	10.66**	F=1.30	143241	21014
	1.17	1.18	0.90	3.91	p=0.267		
			iii: V≡Maritime Ad-valorem Transport Costs				
Labor Prod.	14.16***	15.76***	14.66***	11.19***	F=5.44**	248918	39999
	1.26	1.50	1.30	1.70	p=0.022		
TFP	20.49***	21.61***	20.83***	18.38***	F=2.47	248918	39999
	1.36	1.61	1.40	1.79	p=0.119		
TFP,Diff-in-Diff	6.40***	6.69***	6.49***	5.86***	F=0.21	204041	33334
	0.81	0.99	0.82	1.47	p=0.647		
Levinsohn-Petrin	14.41***	14.39***	14.40***	14.44***	F=0.00	159483	23828
	1.28	1.41	1.29	1.72	p=0.979		

Notes: *, **, *** Statistically significant at the 10 percent, the 5 percent, the 1 percent level, respectively.

Table 2: **...continued**

	Mean V	Bottom Decile V	Median V	Top Decile V	Wald-Test Top=Bottom	Obs.	Firms
Corollary 4							
i: V≡Capital intensity of domestic firms							
Labor Prod.	13.66***	12.75***	13.34***	15.05***	F=2.51	252289	40234
	1.33	1.60	1.41	1.34	p=0.116		
TFP	19.81***	16.73***	18.70***	24.56***	F=21.25***	252289	40234
	1.33	1.62	1.41	1.47	p=0.000		
TFP,Diff-in-Diff	6.29***	5.80***	6.12***	7.02***	F=1.58	207757	33710
	0.78	0.90	0.81	0.94	p=0.213		
Levinsohn-Petrin	14.41***	14.26***	14.36***	14.57***	F=0.48	161552	23934
	1.26	1.31	1.27	1.25	p=0.495		
ii: V≡Average size of domestic sales							
Labor Prod.	13.47***	10.87***	13.48***	15.86***	F=1.79	251951	40219
	1.44	2.93	1.44	1.66	p=0.185		
TFP	19.83***	15.20***	19.84***	24.13***	F=7.33***	251951	40219
	1.38	2.55	1.38	1.68	p=0.008		
TFP,Diff-in-Diff	6.26***	5.32***	6.27***	7.11***	F=1.21	207308	33705
	0.80	1.25	0.80	1.03	p=0.273		
Levinsohn-Petrin	14.46***	14.69***	14.46***	14.24***	F=0.02	161534	23928
	1.34	2.49	1.34	1.49	p=0.886		

	Mean V	Bottom Decile V	Median V	Top Decile V	Wald-Test Top=Bottom	Obs.	Firms
Corollary 5							
V ≡ Method of moments estimate of σ							
Labor Prod.	12.92***	22.84***	12.15***	4.66***	F=28.00***	252366	40235
	1.27	2.09	1.31	2.15	p=0.000		
TFP	19.56***	29.27***	18.80***	11.42***	F=23.89***	252366	40235
	1.22	1.91	1.29	2.38	p=0.000		
TFP,Diff-in-Diff	6.00***	12.27***	5.50***	0.63	F=11.12***	207853	33717
	0.90	1.78	0.97	2.08	p=0.001		
Levinsohn-Petrin	14.21***	17.71***	13.96***	11.13***	F=3.35*	161700	23937
	1.24	1.61	1.32	2.56	p=0.081		

Notes: *,**,*** Statistically significant at the 10 percent, the 5 percent, the 1 percent level, respectively.

Table 3: **Long-term EPP in percent, TFP model**

Corollary 1						
Mean V	Bottom Decile V	Median V	Top Decile V	Wald-Test Top=Bottom	Obs.	Firms
V ≡ Productivity Heterogeneity						
13.40***	7.63***	12.31***	20.39***	F=18.85***	177958	29491
(1.31)	(2.08)	(1.40)	(1.79)	p=0.000		
Corollary 2						
Mean V	Bottom Decile V	Median V	Top Decile V	Wald-Test Top=Bottom	Obs.	Firms
i:V≡Average size of foreigns ales						
13.59***	8.38***	13.98***	20.04***	F=5.47***	177851	29486
(1.23)	(2.49)	(1.24)	(3.08)	p=0.000		
ii:V≡Average number of export destinations						
13.16***	5.90***	14.06***	20.08***	F=14.04***	177877	29487
(1.18)	(2.28)	(1.19)	(2.18)	F=0.000		
Corollary 3						
Mean V	Bottom Decile V	Median V	Top Decile V	Wald-Test Top=Bottom	Obs.	Firms
i:V≡Share of foreign sales of exporters						
14.03***	12.72***	14.04***	15.13***	F=2.17	177851	29486
(1.30)	(1.67)	(1.30)	(1.41)	p=0.144		
ii: V≡Gravity model distance parameter						
13.78***	14.61***	13.95***	12.68***	F=0.14	161661	26650
(1.46)	(1.97)	(1.30)	(3.83)	p=0.708		
iii: V≡Maritime Ad-valorem Transport Costs						
14.13***	15.06***	14.42***	12.33***	F=1.83	175580	29309
(1.38)	(1.61)	(1.42)	(1.80)	p=0.179		
Corollary 4						
Mean V	Bottom Decile V	Median V	Top Decile V	Wald-Test Top=Bottom	Obs.	Firms
i: V≡Capital intensity of domestic firms						
13.68***	11.81***	13.05***	16.18***	F=8.68***	177900	29489
(1.40)	(1.72)	(1.48)	(1.37)	p=0.004		
ii: V≡Average size of domestic sales						
13.67***	11.17***	13.67***	15.87***	F=2.00	177630	29487
(1.45)	(2.68)	(1.45)	(1.66)	p=0.161		
Corollary 5						
Mean V	Bottom Decile V	Median V	Top Decile V	Wald-Test Top=Bottom	Obs.	Firms
V ≡ Method of moments estimate of σ						
13.30***	20.09***	12.80***	7.20***	F=21.75***	177958	29491
(1.28)	(1.52)	(1.32)	(2.13)	p=0.000		

Notes:*,**,***Statistically significant at the 10 percent, the 5 percent, the 1 percent level, respectively.

Table 4: **EPP in percent, TFP model with** $\ln Y_{it-3}$

Mean V	Bottom Decile V	Median V	Top Decile V	Wald-Test Top=Bottom	Obs.	Firms
Corollary 1						
V ≡ Productivity Heterogeneity						
4.55***	2.87***	4.20***	6.50***	F=8.62***	146898	26015
(0.74)	(0.98)	(0.76)	(0.94)	p=0.004		
Corollary 2						
i:V≡Average size of foreigns ales						
4.65***	2.28***	4.79***	7.53***	F=5.12**	146814	26012
(0.75)	(1.22)	(0.76)	(1.55)	p=0.026		
ii:V≡Average number of export destinations						
4.57***	2.10***	4.85***	6.81***	F=5.41**	146848	26014
(0.81)	(1.46)	(0.79)	(1.11)	p=0.022		
Corollary 3						
i:V≡Share of foreign sales of exporters						
4.80***	3.49***	4.80***	5.95***	F=2.90*	146814	26012
(0.75)	(1.13)	(0.75)	(0.95)	p=0.092		
ii: V≡Gravity model distance parameter						
4.79***	4.97***	4.83***	4.54***	F=0.04	133563	23562
(0.77)	(1.24)	(0.80)	(1.39)	p=0.841		
iii: V≡Maritime Ad-valorem Transport Costs						
4.81***	4.77***	4.80***	4.90***	F=0.01	145284	25919
(0.75)	(0.83)	(0.74)	(1.25)	p=0.924		
Corollary 4						
i: V≡Capital intensity of domestic firms						
4.21***	2.78***	3.70***	6.40***	F=12.63***	146847	26012
(0.79)	(0.97)	(0.84)	(0.86)	p=0.000		
ii: V≡Average size of domestic sales						
4.38***	1.73	4.38***	6.80***	F=6.01**	146606	26004
(0.78)	(1.42)	(0.78)	(1.17)	p=0.0160		
Corollary 5						
V ≡ Method of moments estimate of σ						
4.28***	7.23***	4.04***	1.69	F=12.04***	146898	26015
(0.75)	(0.99)	(0.77)	(1.18)	p=0.001		

Notes:*,**,***Statistically significant at the 10 percent, the 5 percent, the 1 percent level, respectively.