ON EXPORT PREMIA

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On Export Premia*

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Abstract

This paper formally shows that the magnitude of the export premium, the fact that exporters are more productive than non-exporters, conveys little economic information on the underlying selection mechanism into export markets for two major reasons. First, variations in export premia may reflect differences in product and factor market imperfections. Second, under the assumption that the *true* productivity of firms follows a log-normal distribution, we show that a large export premium does not necessarily entail high export costs. This is due to the non-monotonic relationship between the export productivity cutoff point and the corresponding export premium.

Key words: Exporter; Export premia; Firm heterogeneity
JEL classification code: F1, D24

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1 Introduction

Exporters are, on average, more productive than non-exporters. This is known as the export productivity premium in the literature on firm heterogeneity and international trade (e.g., Bernard and Jensen, 1999). In fact, such export premia are commonly observed across countries (Van Biesebroeck, 2008). The International Study Group on Exports and Productivity (ISGEP) (2008) estimated a series of export premia in 14 countries based on labour productivity. They found significantly positive export premia in 13 out of 14 countries. While this is one of the most robust empirical regularities, export premia exhibit a large variation across countries. For example, ISGEP (2008) indicate that positive export premia vary from 3.6 percent (Italy) to 16.4 percent (Colombia).

Why do export premia vary so much across countries? The most intuitive answer is that such differences reflect heterogeneity in the underlying selection mechanisms into export markets, such as, for example, differences in trade costs. ISGEP (2008) argued that the theoretical models of heterogeneous firm and trade suggests a positive relationship between export premia across countries and the export productivity cutoff, i.e. the productivity threshold above which firms are able to reach export markets. This is because "in countries where trade costs are lower more firms will be able to enter the export market, not just those at the very top of the productivity distribution" (ISGEP, 2008, p.622). However, the question is more complex, because the export premium depends not only upon the productivity cutoff but also upon the dispersion of firm productivity.

The main contribution of this paper is to formally reveal the systematic relationship between the export premium, firm distribution, and the productivity cutoff point. Under the assumption of log-normal productivity distribution, we advance three propositions. The first proposition shows that the gap between the average productivity level of exporters and the overall industry average can be decomposed into the dispersion of productivity levels and the productivity cutoff. Proposition 2 states that the relationship between the export premium and the productivity cutoff is non-monotonic while Proposition 3 states that the relationship between the export premium and the dispersion parameter of the productivity distribution is always positive.

A number of studies documented the positive export premia. For example, Bernard et al. (2018), Mayer and Ottaviano (2008), Kimura and Kiyota (2006) found positive export premia for the US firms, European firms, and Japanese firms, respectively. However, in most previous studies, export premia are measured not by physical (i.e., quantity-based) productivity but by revenue (i.e., revenue-based) productivity that could reflect technical efficiency, product market imperfections, and/or factor market imperfections. In other words, export productivity premia may reflect aspects other than true differences in physical productivity between exporters and non-exporters. It may instead express differences in product and/or factor market imperfections.[1] An advantage of our analysis is that our discussion holds irrespective of the measurement of productivity (i.e., revenue as well as physical productivity), although a careful interpretation is needed in case of revenue productivity.

Our study also contributes to the literature on the estimation of the export entry costs. Several studies such as Das et al. (2007), Aw et al. (2008), and Kropf and Sauré (2014) have developed methods to estimate the export entry costs.[2] While the proposed frameworks so far are precise and sophisticated, they are sometimes complicated. For example, the framework proposed by Das et al. (2007) developed a structural model and estimated it using a Bayesian Monte Carlo Markov chain estimator. Noting that the export sunk costs have a one-to-one relationship with the export productivity cutoff, we propose a simple and tractable framework that allows one to recover the export productivity cutoff from the firm productivity distribution.

In addition, our study is related to the study on cross-country productivity comparison by Bellone et al. (2014) that succeeded in relating export heterogeneity with the international (industry average) productivity gap: in the presence of firm heterogeneity and differentiated trade costs across countries, the firm-selection effect partly determines the international productivity gap. We extend the framework proposed by Bellone et al. (2014), building upon Kiyota et al. (2019) that showed that the cross-country exporter productivity gap depends upon three suf-

[1] For example, Smeets and Warzynski (2013) compute firm-level price index and found that export premia were significantly larger when output was deflated with firm-level price index rather than the traditional sector-level price index. Garcia-Marin and Voigtländer (2019) also presented similar findings, estimating physical productivity at the firm level.

[2] Timoshenko (2015) also emphasized the importance of the sunk costs although the study did not quantify the magnitude of sunk costs.

ficient statistics: the industry average productivity gap between two countries; the export participation rates; and export premia.

2 Statistical Framework

2.1 Productivity and the export premium

Our initial intuition is that the magnitude of the export premium – so extensively documented in the empirical literature on trade and firm efficiency – bears little economic information on the underlying selection mechanism into export markets. This contention holds irrespective the underlying productivity distribution on the one hand, and irrespective of the presence, or not, of measurement errors of the productivity measure.

Concerning the former, let μ_X and μ_D be the average productivity gap for exporters and domestic firms (firms focusing on the domestic market), respectively.[3] Let N, N_X and N_D be the number of all firms, exporters, and non-exporters, respectively, where $N = N_X + N_D$. Following Kiyota et al. (2019), write the overall level of productivity μ as the weighted average of the levels of productivity of domestic and exporting firms $\mu = \Omega\mu_X + (1-\Omega)\mu_D$, where $\Omega = N_X/N$ is the export participation rate, i.e., the share of firms exporting to foreign markets. Subtracting μ_X from both sides and rearranging terms yields:

$$\mu_X = \mu + (1-\Omega)(\mu_X - \mu_D) = \mu + (1-\Omega)P_X, \tag{1}$$

where P_X is the export premium, that is, the productivity difference between exporters and non-exporters. Equation (1) states that the mean level of productivity of exporting firms is a function of the overall level of productivity of active firms μ and the product of the *domestic* participation rate $(1-\Omega)$ and the export premium $P_X = \mu_X - \mu_D$.

Equation (1) also states:

$$\text{sign}[\mu_X - \mu] = \text{sign}[(1-\Omega)P_X]. \tag{2}$$

[3] Strictly speaking, we presume that μ_X and μ_D are the quantity-based productivity. In Section 2.2, we discuss about the case of revenue-based productivity.

Because the share of non-exporters is greater than zero (i.e., $(1-\Omega)>0$), the positive export premium means that the productivity of exporters exceed the industry average irrespective of the productivity distribution.[4]

2.2 Measurement of productivity

Concerning the measurement of productivity, the main argument is that what has been interpreted as a *true* productivity premium is, in fact, a revenue-based productivity premium. Although not entirely identical to profitability, which relates firm revenues with a vector of expenses concerning the use of capital, labour and material, revenue-based productivity is similar in that it does not satisfactorily wipe out price differences across firms within an industry.

To see this, we follow De Loecker and Goldberg (2014) and first observe that empirical economists essentially use firm-level financial statements where all variables are expressed in nominal terms. Ideally, one would want to estimate a production function where values are instead expressed in real terms. Using smaller cases to denote log values, the ideal situation is to estimate the following production function:

$$q_{it} = \mathbf{x}_{it}'\alpha + \omega_{it}, \tag{3}$$

where q_{it} represents the quantity produced by firm i at time t, $\mathbf{x}$ is the vector of factor input expressed in quantities and α represents the output elasticities of each factor input. The term ω_{it} is quantity-based productivity and is obtained as the difference between observed quantity produced and their expected value $\omega_{it} = q_{it} - \mathbf{x}_{it}'\alpha$.[5] Equation (3) implies that in order to properly measure ω_{it}, one must be able to account for quantities both in the LHS and RHS variables. It is possible to rewrite Equation (3) where prices appear explicitly. The structural equation then becomes:

$$s_{it} = (\mathbf{e}_{it} - \mathbf{z}_{it})'\alpha + \omega_{it} + p_{it}, \tag{4}$$

where p_{it} and $\mathbf{z}_{it}$ represent firm-specific price series on the product and factor markets, respectively, $s_{it} = q_{it} + p_{it}$ and represents nominal sales, and $e_{it} = x_{it} + z_{it}$

[4] Some distributions such as the Cauchy distribution do not have a mean. However, such distributions are rarely used in economic studies.

[5] In this subsection, we focus on total factor productivity.

and represents nominal costs. Equation (4) is convenient to show that one recovers two residuals, giving rise to two measures of productivity depending on the whether one actually accounts for firm-specific prices. The first residual is called quantity-based – or physical – productivity. Using information on firm-specific prices, one immediately recovers physical productivity by computing the residual $\omega_{it} = (s_{it} - p_{it}) - (\mathbf{e}_{it} - \mathbf{z}_{it})'\alpha$. From (4), one can also compute a second residual as follows: $\pi_{it} = s_{it} - \mathbf{e}_{it}'\alpha = \omega_{it} + p_{it} - \mathbf{z}_{it}'\alpha$. Residual π_{it} is called revenue-based productivity because it embodies price differences across firms in both the product and the factor markets.

Confronted with nominal values, researchers would ideally use firm-specific price series, in order to properly estimate physical productivity ω_{it}. However with notable exceptions,[6] such series are generally unavailable to economists, who instead rely on the use of industry-wide price series to express quantities. Let p_t^I and $\mathbf{z}_t^I$ be the industry-level price indices. Denoting $p_{it}^* = p_{it} - p_t^I$ and $\mathbf{z}_{it}^* = \mathbf{z}_{it} - \mathbf{z}_t^I$, it follows immediately that the estimated equation is:

$$s_{it} = (\mathbf{e}_{it} - \mathbf{z}_{it}^*)'\alpha + \omega_{it} + p_{it}^*. \tag{5}$$

It is clear from equation (5) that the residual now reads $\pi_{it} = \omega_{it} + p_{it}^* - \mathbf{z}_{it}^{*}{}'\alpha$. Residual π_{it} remains a measure of revenue-based productivity because it still embodies price differences across firms within an industry. Observe that in a log-linear formulation, firm-specific price p_{it}^* can be expressed as the summation of marginal cost – which itself inversely depends upon productivity and positively upon factor prices – and the price markup: $p_{it}^* = mc(\omega_{it}, \mathbf{z}_{it}^*) + \rho_{it}$.[7] It follows immediately that $\pi_{it} = \omega_{it} + mc(\omega_{it}, \mathbf{z}_{it}^*) + \rho_{it} - \mathbf{z}_{it}^{*\prime}\alpha$. Let the revenue-based productivity of exporters, non-exporters, and export premium be $\tilde{\mu}_X$, $\tilde{\mu}_D$, and $\tilde{P}_X$, respectively. Then the revenue-based productivity premium $\tilde{P}_X$ documented in the literature may reflect a host of factors which extends well beyond quantity-based productiv-

[6] See for example Garcia-Marin and Voigtländer (2019).

[7] For the sake of simplicity, we assume that the vector of factor output elasticities α is common to all firms.

ity:

$$\begin{aligned}
\tilde{P}_X &= \tilde{\mu}_X - \tilde{\mu}_D \\
&= \frac{1}{N_X}\sum_{i\in X}\pi_{it} - \frac{1}{N_D}\sum_{i\in D}\pi_{it} \\
&= \frac{1}{N_X}\sum_{i\in X}\left(\omega_{it} + mc^*_{it} + \rho_{it} - \mathbf{z}^{*\prime}_{it}\alpha\right) - \frac{1}{N_D}\sum_{i\in D}\left(\omega_{it} + mc^*_{it} + \rho_{it} - \mathbf{z}^{*\prime}_{it}\alpha\right) \\
&= \underbrace{\Delta\overline{\omega}}_{=(\mu_X-\mu_D)} + \Delta\overline{mc}^* + \Delta\overline{\rho} - \Delta\overline{\mathbf{z}^*\alpha}, \qquad (6)
\end{aligned}$$

where $\Delta\overline{\chi} = 1/N_X\sum_{i\in X}\chi - 1/N_D\sum_{i\in D}\chi$, and $\chi \in \{\omega_{it}; mc^*_{it}; \rho_{it}; \mathbf{z}^{*\prime}_{it}\alpha\}$.

Equation (6) states that the revenue-based productivity premium may certainly reflect quantity-based productivity differences between exporters and non-exporters $\Delta\overline{\omega}(=\mu_X - \mu_D)$, but it may also express differences in price-cost markups $\Delta\overline{\rho}$, in marginal cost $\Delta\overline{mc^*}$, or in input factors prices $\Delta\overline{\mathbf{z}^*}$. All types of scenario can be envisaged. For example, according to Rauch's classification, most tradables are differentiated products (Rauch, 1999, Table 2). If firms produce differentiated products, then their prices will differ along with their process efficiency. With constant markups, then revenue-based productivity will be inversely proportional to the firms' true efficiency levels ω_{it}.

Instead, one could consider variable markups, and assume a market structure such that markups are increasing in efficiency. But then revenue-based productivity will not inherit the distribution of efficiency, i.e. quantity-based productivity. It will be some generally nonlinear translation of efficiency. Thus, one cannot generally infer the distribution of efficiency from the distribution of revenue productivity. Only with information of the true economic markups, one could imagine to recover the true distribution of ω_{it}.[8] Turning to factor markets, the mapping of $\Delta\overline{\mathbf{z}}$ onto $\Delta\overline{\omega}$ is unclear. Recent work by Dobbelaere and Kiyota (2018) examine the product and labour market imperfections for Japanese firms. The authors show that exporters are more likely to charge higher markups and that exporters were more likely to share rents based on the bargaining power of workers.

The conclusion is crystal clear. There is little hope for an exact mapping of $\Delta\overline{\pi}$

[8]See also Garcia-Marin and Voigtländer (2019) for a convincing attempt to measure both revenue-based and quantity-based productivity.

onto $\Delta\overline{\omega}$, and without data on firm-specific prices, one should not overstate the existence of the revenue-based export premium. Past empirical works such as, *inter alia*, ISGEP (2008), have documented an export premium based on revenue productivity which varies greatly across countries. Yet the reasons for this variation remain blurred. It may stem from imperfections on the product or the factor markets, and from differences in the *true* – quantity-based – levels of productivity between exporters and non-exporters.

But would such a premium provide meaningful information once we rule out the possibility of measurement errors? After all, increased access to higher quality data at the firm level and better estimation techniques may leave this door open in a foreseeable future.[9] The remainder of this paper contents that, even in such an ideal situation, the magnitude of the export premium conveys little information on the selection mechanism for entry into export markets.[10]

2.3 The export premium under the log-normal assumption

Let us now assume that, conditional on entry into the market, firm productivity ω_i can be approximated by a log-normal distribution.[11] While a number of studies such as Chaney (2008) assumed that firm productivity follows the Pareto distribution, several studies such as Kasahara and Lapham (2013), Head et al. (2014), Bellone et al. (2014), and Fernandes et al. (2018) relied on the log-normal distribution as an alternative approach. A recent study by Nigai (2017) proposed a mixed distribution where the left tail is modeled as log-normal while the right tail as Pareto. As Head et al. (2014) note, the log-normal distribution fits the complete distribution of firm sales, rather than merely approximating its right tail. Indeed, the log-normal distribution has been shown to capture the firm size distribution better than the Pareto distribution.[12] Moreover, the log-normal distribution maintains some desirable analytic features of the Pareto distribution. For example, raising the variables from the Pareto and log-normal distributions to a power maintains the original distribution. Overall, although one cannot claim that the assumption

[9] See De Loecker and Goldberg (2014) for possible technical solutions.

[10] In addition, the discussion of the remainder of this paper holds for both labour productivity and total factor productivity.

[11] For ease of exposition, we abstract from time subscript t in this subsection.

[12] Growiec et al. (2008), among others, show that the distribution of firm size does not necessarily have heavy tails.

of normality in the distribution of firm productivity is systematic in the literature, it is reasonable to state that its use is pervasive.

Under the log-normal assumption, the probability density and cumulative distribution functions of which are denoted $\phi(\cdot)$ and $\Phi(\cdot)$ with mean μ and standard deviation σ.[13] Assume further that, in order to cope with sunk export costs c_X, firms must reach a given of productivity cutoff point ω_X. Under perfect sorting, all firms exceeding the country-specific, productivity cutoff ω_X manage to export, whereas firms failing to reach the cutoff focus on the domestic market.

Define $z = (\omega_X - \mu)/\sigma$. In this case, the usual z statistics must be interpreted as the productivity cutoff relative to the productivity distribution of the country. This implies that the term $(1 - \Phi(z))$ provides us with the export participation rate, which increases (decreases) as ω_X decreases (increases). In the same fashion, $\Phi(z)$ provides the share of companies focusing exclusively on the domestic market.

[Figure 1 about here.]

Figure 1 provides a summary of our statistical framework in case of a log-normal firm-level productivity distribution. The shaded areas represent the theoretical case where all firms located to the right of the productivity cutoff ω_X reach foreign markets, whereas firms located to the left of the cutoff focus on domestic markets. Figure 1 also displays the average productivity levels for all firms (μ) and for exporters only (μ_X).

Proposition 1: *If the firm-level productivity distribution is log-normal and if the export premium is positive ($P_X > 0$), it is then possible to decompose the difference between the productivity of exporters and all firms into a productivity cutoff ω_X and a firm heterogeneity σ.*

Proof: If the firm-level productivity distribution is log-normal, the average productivity level of exporters μ_X reads as follows:

$$\mu_X = E(\omega|\omega_i > \omega_X) = \mu + \sigma \frac{\phi(z)}{1 - \Phi(z)}. \tag{7}$$

From equation (7), one can recover information on the difference between the productivity of exporters and all firms by recursive thinking. If one observes the

[13] Hence this assumption means that productivity is log-normally distributed.

export participation rate $\Omega = 1 - \Phi(z)$, one can retrieve the relative export productivity cutoff z. Now, let $\lambda(z) = \phi(z)/(1 - \Phi(z))$, which implies that the function λ is the hazard function of the standard normal distribution. If one observes z, one can immediately deduce that $\lambda(z) = \phi(z)/(1 - \Phi(z))$. Observing both μ and μ_X, the industry average productivity and the export premium, respectively, one can write from equation (7) the following:

$$\mu_X - \mu = \sigma \frac{\phi(z)}{1 - \Phi(z)}. \tag{8}$$

Using equation (8), one can then compute the heterogeneity parameter $\sigma = (\mu_X - \mu) \times \{\phi(z)/(1 - \Phi(z))\}^{-1}$. Having information on z, σ, μ and knowing that $z = (\omega_X - \mu)/\sigma$, recovering information on ω_X is straightforward.

Note that $\lambda(z) > 0$. From equation (2), the necessary condition for equation (8) to be held is $P_X > 0$ as was discussed in the previous subsection. ■

Under the log-normal assumption, one can decompose the difference between the productivity of exporters and all firms into export markets into two terms. Parameter σ relates to heterogeneity in the productivity distribution, and parameter ω_X relates to the productivity cutoff for entering export markets. Note also that, unlike Das et al. (2007), the productivity cutoff can easily be estimated under this framework. Although our framework is not able to quantify the export sunk cost, it allows quantifying the export productivity cutoff with the necessary information on the industry productivity average μ, the productivity of exporters μ_X, and the export participation rate Ω.

2.4 Export premium, export cutoff, and firm heterogeneity

This subsection explores how the productivity premium P_X is affected by changes in the export cutoff ω_X and in the heterogeneity parameter σ. An important implication of the latter is that the magnitude of the export premium does not convey much information about the performance of exporters across countries, i.e., that large export premia do not necessarily imply that exporters are competitive on international markets.

Under perfect sorting, all firms exceeding the country-specific, productivity cutoff ω_{c_X} manage to export, whereas firms failing to reach the cutoff focus on the domestic market. This result implies that the average productivity levels of exporters and non-exporters in a given country are the following truncated means:

$$\mu_X = \mu + \sigma \frac{\phi(z)}{1 - \Phi(z)}, \tag{9}$$

and

$$\mu_D = \mu - \sigma \frac{\phi(z)}{\Phi(z)}, \tag{10}$$

where $\phi(\cdot)$ and $\Phi(\cdot)$ are the probability density function and the cumulative distribution function, respectively, of the standard normal, subscripts X and D denote exporters and non-exporters, respectively. Variable z is defined as $z = \frac{(\omega_X - \mu)}{\sigma}$, where μ and σ are the first and second moment of the normal distribution of the productivity distribution. The productivity export premium P_X, defined as the difference between the mean level of productivity of exporters and that of non-exporters within a country, reads:

$$P_X = \sigma \frac{\phi(z)}{[1 - \Phi(z)]\Phi(z)}. \tag{11}$$

Note that P_X is a function of σ and z. Similarly to Proposition 1, the following lemma is immediately obtained:

Lemma: *If the firm-level productivity distribution is log-normal and if the export premium is positive ($P_X > 0$), it is then also possible to decompose the export premium P_X into a productivity cutoff ω_X and a firm heterogeneity σ.*

Observe that parameter σ and expression $\frac{\phi(z)}{[1-\Phi(z)]\Phi(z)}$ are always positive, so that P_X is always positive. This is a direct consequence of the perfect sorting assumption. Given this framework, we provide the following proposition:

Proposition 2: *The effect of the export cutoff ω_X on the export premium P_X is non-linear. When P_X is lower than the average productivity level of the industry μ, an increase in ω_X decreases the export premium P_X. When P_X is higher than the average productivity level of the industry μ, an increase in ω_X increases the export premium P_X.*

Proof: In order to analyse how the export cutoff affects the productivity premium, we must analyse $\partial P_X / \partial \omega_X$. This is tantamount to analysing the following:

$$\frac{\partial P_X}{\partial \omega_X} = \frac{\partial P_X}{\partial z}\frac{\partial z}{\partial \omega_X}$$

Let us first start by analysing $\partial P_X/\partial z$, yielding:

$$\frac{\partial P_X}{\partial z} = \sigma \frac{-z\phi(z)(1-\Phi(z))\Phi(z) - \phi(z)^2[1-2\Phi(z)]}{\left[(1-\Phi(z))\Phi(z)\right]^2}. \tag{12}$$

We know that both σ and the denominator, because of the squared term, are always positive, so that the sign of equation (12) depends ultimately upon the sign of the numerator: $-z\phi(z)(1-\Phi(z))\Phi(z) - \phi(z)^2[1-2\Phi(z)]$. Dividing through by $\phi(z)$ yields the following necessary condition for the first derivative to be positive:

$$\frac{\mathrm{d}}{\mathrm{d}z}P_X > 0 \quad \text{iif} \quad z < \frac{\phi(z)}{1-\Phi(z)} \cdot \left[2 - \frac{1}{\Phi(z)}\right]. \tag{13}$$

A simple numerical application shows that condition (13) holds so long as $z > 0$. Therefore, $\partial P_X/\partial z > 0 \quad \forall z \in \Re^+$, $\partial P_X/\partial z = 0$ if $z = 0$, $\partial P_X/\partial z < 0 \quad \forall z \in \Re^-$.

It is straightforward to show that $\partial z/\partial \omega_X = 1/\sigma$, which is always positive. Table 1 recapitulates our findings. It shows that the effect of the productivity cutoff ω_X is non-monotonic, and lowest when z equals nullity, that is, when $\omega_X = \mu$. ■

[Table 1 about here.]

Proposition 2 says that the magnitude of the export premium is partly determined by the export participation rate: high premium comes from an export productivity cutoff ω_X which significantly departs from the mean level of productivity μ. Basically, there are two reasons for which the premium can be large. The first reason is that the severity of the selection ensures that only the most productive firms make it to foreign markets, resulting in a high premium. The second reason is the converse: the lack of selection screens out only the least productive, exacerbating the premium as a result. An important implication is that the magnitude of the export premium does not convey much information about the performance of exporters on international markets. Some studies such as ISGEP (2008) argued that the theoretical models of heterogeneous firm and trade suggests a positive relationship between the export cutoff and the exporter premium across countries. However when firm productivity is log-normally distributed, Proposition 2 shows that this does not hold. Consequently, larger premia do not mechanically reflect higher entry costs into export markets.

In a similar fashion, we propose:

Proposition 3: *The effect of heterogeneity σ on the productivity export premium P_X is positive.*

Proof: From equation (11), let $u = \sigma$ and $v(z) = \phi(z)/[(1-\Phi(z))\Phi(z)]$. We can therefore write:

$$\frac{\partial P_X}{\partial \sigma} = u'v + uv' \tag{14}$$

$$= v(z) + \sigma \frac{\partial v(z)}{\partial \sigma}. \tag{15}$$

Knowing that $\partial z/\partial \sigma = -(1/\sigma)z$, we have:

$$\sigma \frac{\partial v(z)}{\partial \sigma} = \sigma \frac{\partial v(z)}{\partial z}\frac{\partial z}{\partial \sigma} \tag{16}$$

$$= \sigma \frac{-z\phi(z)(1-\Phi(z))\Phi(z) - \phi(z)^2[1-2\Phi(z)]}{\left[(1-\Phi(z))\Phi(z)\right]^2} \cdot \left(\frac{-z}{\sigma}\right) \tag{17}$$

$$= z\frac{z\phi(z)(1-\Phi(z))\Phi(z) + \phi(z)^2[1-2\Phi(z)]}{\left[(1-\Phi(z))\Phi(z)\right]^2}. \tag{18}$$

Therefore,

$$\frac{\partial P_X}{\partial \sigma} = \frac{\phi(z)}{[1-\Phi(z)]\Phi(z)} + z\left(\frac{z\phi(z)(1-\Phi(z))\Phi(z) + \phi(z)^2[1-2\Phi(z)]}{\left[(1-\Phi(z))\Phi(z)\right]^2}\right). \tag{19}$$

The first term in the RHS of equation (19) $\frac{\phi(z)}{[1-\Phi(z)]\Phi(z)}$ is always positive. This is less clear for the second term $z\left(\frac{z\phi(z)(1-\Phi(z))\Phi(z)+\phi(z)^2[1-2\Phi(z)]}{\left[(1-\Phi(z))\Phi(z)\right]^2}\right)$. From condition (13), we know that the numerator $z\phi(z)(1-\Phi(z))\Phi(z)+\phi(z)^2[1-2\Phi(z)]$ is positive when $z>0$. Conversely, it becomes negative when $z<0$. Because this numerator is multiplied by z itself, it is straightforward to observe that $z\left(\frac{z\phi(z)(1-\Phi(z))\Phi(z)+\phi(z)^2[1-2\Phi(z)]}{\left[(1-\Phi(z))\Phi(z)\right]^2}\right)>0 \quad \forall z \in \Re$. Therefore $\frac{\partial P_X}{\partial \sigma}>0 \quad \forall z \in \Re$. ■

[Figure 2 about here.]

Proposition 3 states that large export premia imply substantial firm heterogeneity within a country. Figure 2 corroborates the Proofs, and shows how the export premium P_X is affected by the export cutoff ω_X and firm heterogeneity σ, where darker colors indicate higher values for the export premium. Simulations have been chosen for $\mu=10$, various measures of σ ranging from .1 to 6 and various values for ω_X ranging from 0 to 20.

3 Conclusion

This paper has formally shown that the magnitude of the export premium bears little economic information on the underlying selection mechanism into export markets for two major reasons. First, past empirical works has essentially documented an export premium based on revenue productivity. This variation may reflect differences in product and factor market imperfections and there is little hope for an exact mapping of revenue productivity onto quantity productivity.

Second, under the assumption that the *true* productivity of firms follows a log-normal distribution, the productivity gap between exporters and the overall industry average can be decomposed into a dispersion parameter and the selection parameter, i.e. the productivity cutoff. This led to two additional propositions. First, large export premia imply substantial firm heterogeneity within a country. Second, large export premia do not imply a large export productivity cutoff. This is due to the non-monotonicity in the relationship between the export premium and productivity cutoff. Consequently, larger premia cannot mechanically reflect higher entry costs into export markets.

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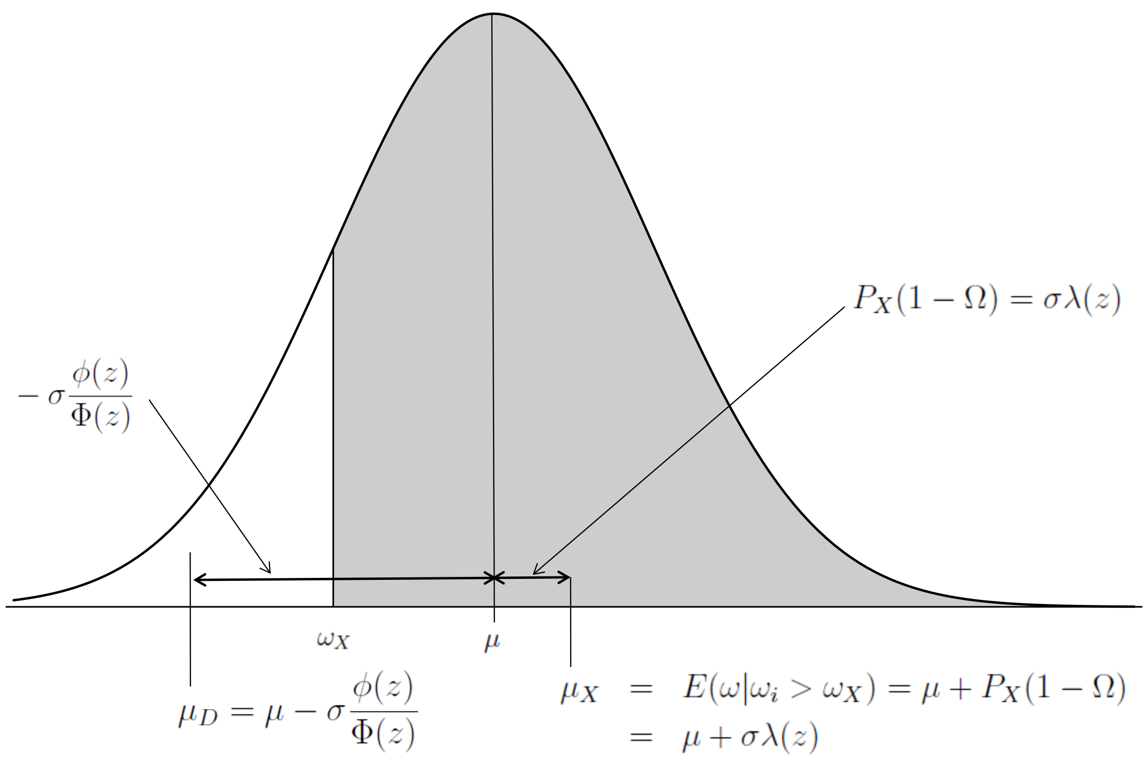
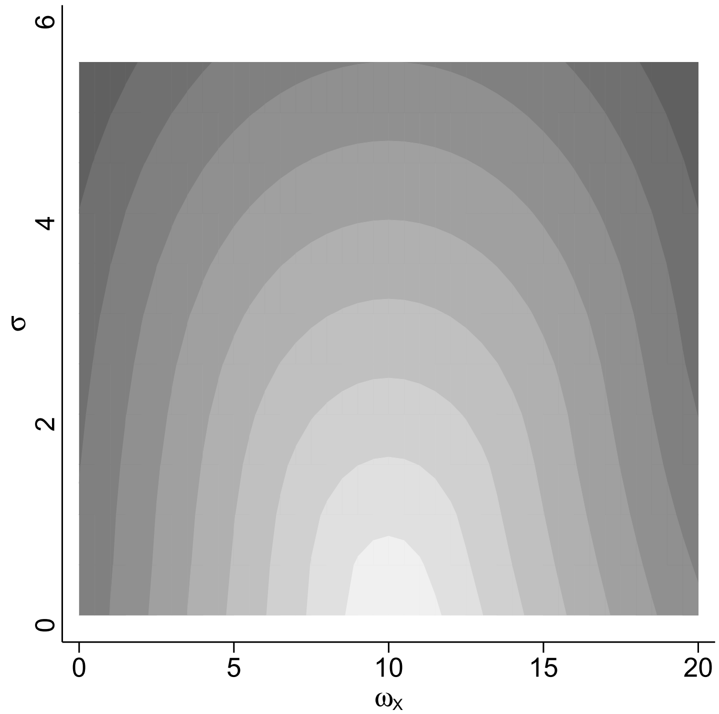
Figure 1: Exporter Productivity Gaps as a Function of the Export Threshold Value



Note: Shaded area indicates the share of exporters (Ω).

Figure 2: Export Productivity Threshold ω_X, Heterogeneity σ and the Export Premium P_X



Notes: $\mu = 10$. Darker colors indicate higher values for the export premium.

Table 1: How the export cutoff ω_X affects the export premium

	$z < 0$	$z = 0$	$z > 0$
$\frac{\partial P_X}{\partial z}$	< 0	$= 0$	> 0
$\frac{\partial z}{\partial \omega_X}$	> 0	> 0	> 0
$\frac{\partial P_X}{\partial \omega_X}$	< 0	$= 0$	> 0

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