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What's Behind the Figures? Quantifying the Cross-Country Exporter Productivity Gap*

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Abstract

We present a simple framework that allows us to examine the cross-country exporter productivity gap without accessing confidential firm-level data. This gap depends on the three readily available statistics: the productivity gap between two countries; the export participation rates; and export premia. This gap holds irrespective of the data generating process and independent of sunk costs of entering domestic markets. Under specific conditions, allocative efficiency may affect the exporter productivity gap. Additional assumptions on the log-normality of the productivity distribution of firms allow one to recover the export threshold and heterogeneity parameters. The empirical analysis globally validates this exercise.

Key words: International productivity gap; Export premia; Competitiveness; Meta analysis.

JEL classification code: F1, D24

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1 Introduction

How can one compare the performance of exporters from different countries? This question has gained enormous momentum in the past decade (e.g., Carlin et al., 2001), first and foremost because exporting firms are regarded as the key actors in economic recovery. Consider the Eurozone countries. Since the financial turmoil of 2008, Eurozone countries have found it difficult to return to their pre-crisis level of economic activity. Austerity policies have depressed internal demand, making it key for the country to recover growth *via* distant markets. A better understanding of the behaviour and performance of exporters is therefore needed for policy makers to implement successful export policies.

Increased awareness of the benefits of exports for economic growth is accompanied by a broadening reliance on firm-level information (International Study Group on Exports and Productivity (ISGEP), 2008). The well-documented productivity premium has made it clear that in many respects, exporters outperform non-exporters within a given country. However, it is difficult to provide an economic interpretation for the magnitude of the productivity premium enjoyed by exporters, and a large export premium does not mechanically imply a productivity advantage of these exporters relative to their foreign competitors. In other words, little can be said about how exporters from one country perform with respect to exporters from other countries.

The main contribution of this paper is to encourage economists to use readily available data to actually assess and compare the performance of exporters from different countries. Our intuition is that readily available figures conceal additional information that allows one to compare exporters from different countries. To do so, we advance four propositions. The first proposition is based on a simple identity to show that the productivity gap between exporters can be assessed by using three basic statistics. Proposition 2 states that Proposition 1 holds irrespective of the distribution underlying firm productivity and irrespective of the presence of fixed costs. Proposition 3 raises concerns about the use of aggregated statistics and shows that our framework holds either when the productivity gap between exporters is of significant magnitude or, if this gap is narrow, when industry structures are similar across countries. Proposition 4 investigates the particular case of the log-normal distribution and shows that concealed statistics such as heterogeneity in the productivity distribution and entry costs into export markets can be recovered. The paper then empirically explores our propositions by using readily available, aggregated data and testing the validity of the framework by accessing confidential firm-level data.

The remainder of the contribution is structured as follows. The next section explains our analytical framework and explores various dimensions such as concerns regarding the use of aggregated data or assuming a log-normal productivity distribution. Section 4 presents empirical results based on the use of readily available data and on confidential, firm-level data from France and Japan. A summary of our findings and their implications is presented in the final section.

2 Literature Review

The international competitiveness of industries has long been a central issue in the business literature (e.g., Porter, 1990) and in the economics literature (e.g., Fagerberg, 1988; Carlin et al., 2001). In measuring the international competitiveness of industries, previous studies have focused primarily on two aspects. One is productivity (e.g., the comparison of industry-average productivity), and the other is exports (e.g., the comparison of export shares in the world market using revealed comparative advantage). After Melitz (2003) succeeded in developing a model to explain the systematic relationship between firm productivity and exports, a number of studies have examined the relationship between these two values in various countries.[1] However, the focus of the previous studies is limited to the relationship between firm productivity and exports *within a country*. Although the productivity of exporters certainly reflects the international competitiveness of the firms in a country, little attention has been paid to the comparison of the productivity gap across exporters *between countries*.

Some studies such as that conducted by the ISGEP (2008) and by Berthou et al. (2015) have examined the cross-country differences in export premia (i.e., the productivity difference between exporters and non-exporters within a country). However, high export premia do not necessarily imply that exporters will be competitive on international markets. To the best of our knowledge, only Bellone et al. (2014) directly compare the productivity of exporters from two different countries.[2] In other words, although we now know that exporters outperform non-exporters, we do not know much about whether exporters from one country outperform those from another country. The cross-country comparison of exporter performance has not yet been fully explored in the literature.

Focusing on the productivity of exporters is nontrivial. Table 1 presents the ranking of labour productivity for 11 developed countries. One interesting finding is that the United States ranks eighth out of these 11 countries. This low rank is puzzling because it is widely believed that US firms represent the productivity frontier and are therefore

[1] See Greenaway and Kneller (2007); Wagner (2012); Hayakawa et al. (2012) for surveys and Bellone et al. (2008) and Kimura and Kiyota (2006) for evidence from France and Japan, respectively.

[2] Using confidential firm-level data from the French and Japanese manufacturing industries, Bellone et al. (2014) report that the productivity gap across French and Japanese exporters systematically differed from the average industry productivity gap: it is wider in industries in which Japan has a productivity advantage and it is narrower in industries in which France has a productivity advantage. This is due to the differences in the selection effect between Japan and France. As a consequence of the stronger selection of Japanese firms into export markets, the productivity gap between Japanese and French exporters becomes larger than the average productivity gap in industries in which Japan has a productivity advantage.

the most competitive firms in the world. We argue that this puzzle comes from the gap between the productivity of exporters and industry-average productivity (i.e., the productivity of exporters and non-exporters). The average productivity of an industry certainly affects the productivity of exporters. However, as we will show, the productivity of exporters is also the product of the selection of firms into foreign markets and is hence determined by the export participation rate. It follows that high (low) average productivity in an industry does not mechanically imply a high (low) level of productivity for exporting firms.

[Table 1 about here.]

Clarifying the cross-country exporter productivity gap is not an easy task. Some studies have compared the international productivity gap at the firm level.[3] However, most of them have focused on large, listed firms. This choice precludes the ability to address the issue of heterogeneity in the export behaviour of firms, simply because the vast majority of listed companies are exporters. One thus needs access to confidential firm-level data from different countries, which implies that one faces several confidentiality restrictions. For example, Japanese confidential firm-level data are available only within Japan. Similarly, French confidential firm-level data are available only within France. Because of data confidentiality restrictions, one cannot simply merge two or several datasets into one unique dataset.

One additional difficulty remains. To compare productivity levels between different countries, one needs to address the issue of the comparability of inputs and outputs. First, one needs to ensure that the accounting definitions of many firm-level variables stemming from the financial statements are similar, if not identical. Second, the exchange rate between any two currencies does not necessarily yield the proper relative price between countries, due, for example, to short-term capital movements. One needs information on purchasing power parity (PPP) for inputs and outputs (e.g., Jorgenson et al., 1987; Inklaar and Timmer, 2008) if one is to address the issue of the cross-country exporter productivity gap.

Our main contribution is to develop a simple framework that allows one to examine the cross-country exporter productivity gap without directly accessing confidential firm-level data. This framework is based on four propositions that are empirically tested. We show that the average international productivity gap between exporters (P_X^b) depends on the following three sufficient statistics:

1. The industry-average productivity gap between two countries (P^b), which is defined as the average productivity of all firms (exporters and non-exporters);

2. The export participation rate (Ω), which is defined as the ratio of the number of exporters to the number of all firms (exporters and non-exporters);

[3] See, for example, Baily and Solow (2001), Fukao et al. (2011), and Jung and Lee (2010).

3. The export premium (P_X^w) within a country, which is defined as the productivity difference between exporters and non-exporters.

The above three variables can be relatively easily obtained from the literature allowing, for example, the implementation of a meta analysis.

Our framework does not depend upon the productivity distribution so long as the distribution has a mean.[4] Many studies on firm heterogeneity and trade assume that the productivity and/or size of firms follow a Pareto distribution.[5] Some recent studies depart from this assumption. For example, Feenstra (2014) and Melitz and Redding (2015) explore the properties of a bounded (or truncated) Pareto distribution, while Head et al. (2014), Yang (2014), and Bellone et al. (2014) examine those of a log-normal distribution. Our study goes one step further without assuming any specific distribution while addressing the issue of firm heterogeneity and trade.[6]

We apply our framework to cross-country comparisons across 11 advanced countries, such as Japan, the United Kingdom, and the United States, obtaining the relevant information from the literature. The major findings of our paper are twofold. First, the average exporter productivity gap between two countries does not necessarily reflect the industry-average productivity gap due to the differences in export participation rates and export premia between countries. Second, higher export premia do not necessarily reflect higher performance in exporter productivity.

3 Statistical Framework

3.1 A simple identity

Consider a population that consists of two groups 1 and 2. Let $\bar{x}_i$ be the mean of group i, with $i = (1,2)$. The mean of the sample $\bar{x}$, as the weighted average of x_1 and x_2, reads as $\bar{x} = sx_1 + (1-s)x_2$, where s is the share of group 1 in the overall population. Subtracting x_1 from both sides and rearranging terms yields:

$$x_1 = \bar{x} + (1-s)dx, \tag{1}$$

where $dx = x_1 - x_2$. Identity 1 holds if the overall population and its subgroups admit a mean. Now this very simple, if not tautological, identity provides a useful starting point to analyse the exporter productivity gap.

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

[5] See, for example, Melitz (2003).

[6] Bellone et al. (2014) also present a simple framework to relate cross-country productivity gaps to the export status of firms. However, the scope of their framework is limited in the sense that it relies on the assumption that firms' productivity is distributed log-normal. We will show that Bellone et al. (2014) represent a special case of our framework.

Let μ_X and μ_D be the average productivity gap for exporters and domestic firms (firms focusing on the domestic market), respectively. Let N, N_X and N_D be the number of all firms, exporters, and non-exporters, respectively, where $N = N_X + N_D$. Similar to the above general example, the overall industry-average productivity μ reads 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. Now write the overall level of productivity μ as the weighted average of the levels of productivity of domestic and exporting firms μ=$\Omega\mu_X + (1-\Omega)\mu_D$. Subtracting μ_X from both sides and rearranging terms yields:

$$\mu_X = \mu + (1-\Omega)(\mu_X - \mu_D) = \mu + (1-\Omega)P_X^w, \tag{2}$$

where $P_{X,c}^w$ is the well-documented – generally positive – export premium, that is, the productivity difference between exporters and non-exporters. The superscript w denotes the export premium computed using firms active within the same domestic market. Equation (2) 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 $P_X^w = \mu_X - \mu_D$. We call the first component (μ) the *competitiveness effect* and the second component ($(1-\Omega)\cdot P_X^w$) the *selection effect*. Although the former effect is pervasive in the literature on cross-country competitiveness, the selection effect provides information about the threshold productivity levels that companies must reach to cope with sunk costs of entering export markets.

The above general framework is useful if one wishes to establish cross-country comparisons in competitiveness with readily available statistics in the empirical literature on the firm export premium. For any pair of countries, we have the following proposition:

Proposition 1: *The average international exporter productivity gap (P_X^b) depends on three sufficient statistics: 1) the industry-average productivity gap (P^b); 2) the export participation rate Ω; and 3) the export premium in each country (P_X^w).*

Proof: Let $\mu_{X,1}$ and $\mu_{X,2}$, be the mean productivity of exporters in country 1 and country 2, respectively. Using equation (2), the following is immediate:

$$\begin{aligned} P_X^b \equiv \mu_{X,1} - \mu_{X,2} &= \mu_1 + (1-\Omega_1)P_{X,1}^w - \left[\mu_2 + (1-\Omega_2)P_{X,2}^w\right] \\ &= P^b + (1-\Omega_1)P_{X,1}^w - (1-\Omega_2)P_{X,2}^w, \end{aligned} \tag{3}$$

where $(\mu_1 - \mu_2)$ represents the productivity gap between the two countries.■

Proposition 1 is admittedly very simple. However, conditional upon the availability of information on P^b, Ω and P_X^w, it allows for the comparison of country performance in export markets without accessing confidential firm-level data in countries 1 and 2. A direct implication is that, given the same benchmark, pairwise comparisons involving several countries can be recovered. Hence, we have Lemma 1:

Lemma 1: *Given three countries 1, 2 and 3, if the international exporter productivity gap between countries 1 and 3 ($P^b_{X,13}$) and the international exporter productivity gap between countries 2 and 3 ($P^b_{X,23}$) are known, then the international exporter productivity gap between countries 1 and 2 ($P^b_{X,12}$) can be recovered.*

Proof: Let $P^b_{X,13} \equiv \mu_{X,1} - \mu_{X,3}$ and $P^b_{X,23} \equiv \mu_{X,2} - \mu_{X,3}$; the following is immediate:

$$
\begin{aligned}
P^b_{X,13} - P^b_{X,23} &= (\mu_{X,1} - \mu_{X,3}) - (\mu_{X,2} - \mu_{X,3}) \\
&= \mu_{X,1} - \mu_{X,2}. \\
&= P^b_{X,12} \qquad (4)
\end{aligned}
$$

Depending on data availability, pairwise comparisons can be performed.■

3.2 Heterogeneous firms and trade model

Although useful, the above framework does not assume any distribution of firm-level productivity, nor is it based on any formal international trade model *à la* Melitz (2003). In fact, this simple framework is consistent with the heterogeneous firm trade model. To this end, we make the simplifying assumption that firms cope with sunk costs of entering domestic and foreign markets that are common to all firms. Obviously, such costs are firm specific and follow a given distribution, as is the case in Melitz and Ottaviano (2008). Therefore, in our framework, such costs should be viewed as the industry average of a distribution of heterogeneous, firm-specific sunk costs of entering markets, whether domestic or international.

Let ω_i be the logarithm of the productivity of firm i in an industry. Firm productivity is assumed to follow a distribution $\omega \sim g(\omega)$, with $\underline{\omega}$ and $\bar{\omega}$ representing the minimum and maximum values of firm productivity. For the sake of generality, we do not assume any specific parametric distribution at this stage.

Firms cope with two types of sunk entry costs. We define c_D as the cost associated with entering the domestic market and c_X as sunk costs of entering export markets. To cope with c_D and c_X, firm efficiency must exceed the threshold productivity levels ω_D to enter the domestic market and ω_X to enter foreign markets. The literature generally reports that the vast majority of firms focus on domestic markets and fewer export part of their production to foreign markets. Accordingly, we rank the threshold values as follows: $0 < \underline{\omega} < \omega_D < \omega_X < \bar{\omega} < \infty$. Given this setting, the average productivity of firms active in the market reads as follows:

$$\mu = E(\omega|\omega_D < \omega_i < \bar{\omega}) = \frac{\int_{\omega_D}^{\bar{\omega}} \omega g(\omega)d\omega}{\int_{\omega_D}^{\bar{\omega}} g(\omega)d\omega}. \quad (5)$$

Under perfect sorting, all firms exceeding the threshold value export, whereas firms failing to reach the threshold focus on the domestic market. The expected productivity of domestic and exporting firms μ_D and μ_X then read, respectively, as:

$$\mu_D = E(\omega|\omega_D < \omega_i < \omega_X) = \frac{\int_{\omega_D}^{\omega_X} \omega g(\omega)d\omega}{\int_{\omega_D}^{\omega_X} g(\omega)d\omega}, \quad (6)$$

and

$$\mu_X = E(\omega|\omega_X < \omega_i < \bar{\omega}) = \frac{\int_{\omega_X}^{\bar{\omega}} \omega g(\omega)d\omega}{\int_{\omega_X}^{\bar{\omega}} g(\omega)d\omega}. \quad (7)$$

Given this very general framework, we propose the following:

Proposition 2: *Proposition 1 holds irrespective of (i) the truncation of the productivity distribution due to sunk costs of entering the domestic market and ii) the data generating process, that is, the distribution of the productivity distribution so long as the distribution has a mean.*

Proof: Write the overall level of productivity μ as the weighted average productivity of domestic and exporting firms:

$$\mu = \frac{\int_{\omega_X}^{\bar{\omega}} g(\omega)d\omega}{\int_{\omega_D}^{\bar{\omega}} g(\omega)d\omega}\mu_X + \frac{\int_{\omega_D}^{\omega_X} g(\omega)d\omega}{\int_{\omega_D}^{\bar{\omega}} g(\omega)d\omega}\mu_D, \quad (8)$$

where $\int_{\omega_X}^{\bar{\omega}} g(\omega)d\omega / \int_{\omega_D}^{\bar{\omega}} g(\omega)d\omega$ is the share of firms active in export markets (the export participation rate) and $\int_{\omega_D}^{\omega_X} g(\omega)d\omega / \int_{\omega_D}^{\bar{\omega}} g(\omega)d\omega$ is the share of firms focusing on the domestic market (the *domestic* participation rate). Now let Ω be the export participation rate. The domestic participation rate reads as follows:

$$\frac{\int_{\omega_D}^{\omega_X} g(\omega)d\omega}{\int_{\omega_D}^{\bar{\omega}} g(\omega)d\omega} = \frac{\int_{\omega_D}^{\bar{\omega}} g(\omega)d\omega - \int_{\omega_X}^{\bar{\omega}} g(\omega)d\omega}{\int_{\omega_D}^{\bar{\omega}} g(\omega)d\omega} = 1 - \Omega.$$

Inserting Ω and $(1-\Omega)$ into equation (8), subtracting μ_X from both sides and rearranging terms yields

$$\mu_X = \mu + (1-\Omega)(\mu_X - \mu_D) = \mu + (1-\Omega)P_X^w. \quad (9)$$

Whether the data generating process is identical or different across any two countries does not affect equation (9) and, therefore, does not affect equation (3). In the same vein, whether there exist significant differences in fixed costs C_D between countries does not affect the feasibility of the comparison.■

3.3 Aggregation issues

Thus far, the average productivity is the simple, arithmetic mean of the (log of) the productivity parameter of all firms within an industry $\mu = (1/N)\sum_i \omega_i$. Because we do not weight observations, μ represents the unweighted productivity average. However in the literature, most figures stem from industry-level data, meaning that when computing productivity, one necessarily computes the ratio of two sums:

$$\Psi = \frac{\sum_i Q_i}{f(\sum_i \mathbf{V}_i)}, \tag{10}$$

where Q_i and V_i are output and input for firm i and $f(\sum_i \mathbf{V}_i)$ may represent various combinations of inputs. Because larger firms will account for a larger share of the industry summation for both Q and V, Ψ represents the weighted average of the firm-specific productivity terms. Only under very specific industry structures in which all firms have a strictly identical use of inputs and equal market shares will the two productivity averages coincide: $\mu = \Psi$. Because this is very unlikely to hold in practice, one must address the additional issue of aggregate productivity.

By aggregate productivity, we mean the summation of individual, firm-specific measures of some productivity performance ω_i using specific weights, the choice of which is far from univocal. Firms are heterogeneous in their use of inputs and in market shares, and whether one chooses to weight firms using their output shares or their input use does not yield a similar relationship between the unweighted productivity average used in our framework and aggregate productivity (see van Biesebroeck, 2008, for a discussion). In this subsection, we follow Olley and Pakes (1996) and choose to use output weights.

Define the log of weighted average productivity as $\Psi \equiv \sum_i v_i \omega_i$, where $v_i (= Y_i/Y)$ is the market share of firm i; Y_i and $Y (= \sum_i Y_i)$ are the output of firm i and that of all firms, respectively. Let $\bar{v}$ and $\bar{\omega}$ be the simple average of the output share and productivity. As Olley and Pakes (1996) show, the weighted average productivity can be decomposed into the unweighted average productivity and the overall covariance term:

$$\Psi = \bar{\omega} + \sum_i \Delta v_i \Delta \omega_i, \tag{11}$$

where $\bar{\omega} = (1/N)\sum_i \omega_i$, $\Delta v_i = v_i - \bar{v}$ and $\Delta \omega_i = \omega_i - \bar{\omega}$.

Note that $\bar{\omega}$ equates with μ, the unweighted average productivity of all firms. Hence $\bar{\omega}$ is also the weighted average of the productivity of exporters and that of non exporters:

$$\bar{\omega} = \mu = \Omega\mu_X + (1-\Omega)\mu_D. \tag{12}$$

The so-called covariance term $\sum_i \Delta v_i \Delta\omega_i$ is an indicator of allocative efficiency. If firms with higher market shares are also the most productive, the covariance term exceeds zero. A negative covariance term indicates that the least-productive firms are also those with the larger market shares, thus indicating a misallocation of resources across firms active in the market. Therefore, allocative efficiency must reflect institutional and regulatory features that may distort the functioning of markets (Bartelsman et al., 2013). Note that the covariance term can also be written as follows:

$$\sum_i \Delta v_i \Delta\omega_i = N\frac{\sum_i \Delta v_i \Delta\omega_i}{N} = Ncov(\Delta v, \Delta\omega), \tag{13}$$

where $cov(\Delta v, \Delta\omega) \equiv (1/N)\sum_i \Delta v_i \Delta\omega_i$. We thus have

$$\Psi = \mu + Ncov(\Delta v, \Delta\omega). \tag{14}$$

The term $Ncov(\Delta v, \Delta\omega)$ is economically meaningful. The number of firms N relates to competition in a given market, and the covariance $cov(\Delta v, \Delta\omega)$ provides information on what could be thought of as *normalized allocative efficiency*. Computing $\partial cov(\Delta v, \Delta\omega)/\partial\Delta\omega$ yields $(1/N)\sum_i \Delta v_i$. This term can be interpreted as the expected gain in market share for domestic firms stemming from a unit increase in the firm's own productivity relative to the market. In turn, knowledge about the size of the market provides information on profit opportunities. This latter component makes the covariance term comparable across countries and/or industries.

If $Ncov(\Delta v, \Delta\omega)$ is large, i.e., $\Psi > \mu$, then competition and normalized allocative efficiency add to the overall productivity of the market. Conversely if $\Psi \leq \mu$, then a lack of competition and misallocation problems presumably harm economic growth. We therefore propose the following:

Proposition 3: *The comparison of exporter performance between any two countries is compatible with the use of aggregated data* if *allocative efficiency is similar between the two countries.*

Proof: Adding a country-specific subscript c to take into account country differences yields $\Psi_c = \mu_c + N_c cov(\Delta v_c, \Delta\omega_c)$. The weighted average productivity gap between two countries ($c = 1,2$) now reads as follows:

$$\begin{aligned} \Psi_1 - \Psi_2 &= \mu_1 - \mu_2 + N_1 cov(\Delta v_1, \Delta\omega_1) - N_2 cov(\Delta v_2, \Delta\omega_2) \\ &= P^b + N_1 cov(\Delta v_1, \Delta\omega_1) - N_2 cov(\Delta v_2, \Delta\omega_2). \end{aligned} \tag{15}$$

Our framework is consistent with the weighted average productivity gap if the following relationship holds:

$$N_1 cov(\Delta v_1, \Delta\omega_1) = N_2 cov(\Delta v_2, \Delta\omega_2). \quad (16)$$

Differences in allocative efficiency can stem from differences in either competition or profit opportunities. ■

Whether this relationship actually holds is an empirical issue. We will address this issue in Section 4.3.

3.4 The log-normal assumption

The previous subsections make no assumption on the parametric form of the distribution. Instead, let us now assume that firm productivity ω_i can be approximated by a log-normal distribution, the probability density and cumulative distribution functions of which are denoted $\phi(\cdot)$ and $\Phi(\cdot)$ with mean μ and standard deviation σ.[7] While this assumption may not hold in practice, we exploit the simplifying normality assumption to derive a formal relationship between the differentiated export threshold values and the relative productivity gaps.[8]

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.[9] 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.

Assume further that the cost of operation c_D is nil $c_D = 0$, whereas c_X remains significantly positive. Define $z_X = (\omega_X - \mu)/\sigma$. In this case, the usual z statistics must be interpreted as the threshold productivity level relative to the productivity distribution of the country. This implies that the term $(1 - \Phi(z_X))$ provides us with the export participation rate, which increases (decreases) as ω_{c_X} decreases (increases). In the same fashion, $\Phi(z_X)$ 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 the special case of a log-normal distribution associated with no domestic sunk entry costs ($c_D = 0$). The top

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

[8] For example, Okubo and Tomiura (2014) report that the distribution of plant productivity was left skewed.

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

panel represents the within-country case, while the bottom panel represents the between-country case. Observe that by so abstracting, one does not observe the country-specific sunk entry productivity threshold ω_X nor the heterogeneity parameter σ. However, given this framework, we now derive the following proposition:

Proposition 4: *In the absence of domestic fixed costs c_D,* if *the productivity distribution is (log-)normal* and if *the export premium is positive ($P_X^w > 0$), it is then possible to decompose the selection effect into a threshold effect ω_X and a heterogeneity effect σ.*

Proof: Let μ_X be the average productivity of exporters. The average productivity level of exporters in a given country reads as follows:

$$\mu_X = E(\omega|\omega_i > \omega_X) = \mu + \sigma \frac{\phi(z_X)}{1-\Phi(z_X)}. \tag{17}$$

From equation (17), one can recover information on the selection effect by recursive thinking. If one observes the export participation rate $\Omega = 1-\Phi(z_X)$, one can retrieve the relative export threshold z_X. Now, let $\lambda(z_X) = \phi(z_X)/(1-\Phi(z_X))$, which implies that the function λ is the hazard function of the standard normal distribution. If one observes z_X, one can immediately deduce that $\lambda(z_X) = \phi(z_X)/(1-\Phi(z_X))$. Observing both μ and μ_X, the overall level of competitiveness and the export premia, respectively, one can write from equation (17) the following:

$$\mu_X - \mu = \sigma \frac{\phi(z_X)}{1-\Phi(z_X)}. \tag{18}$$

Using equation (18), one can then compute the heterogeneity parameter $\sigma = (\mu_X - \mu) \times \{\phi(z_X)/(1-\Phi(z_X))\}^{-1}$. Having information on z_X, σ, μ and knowing that $z_X = (\omega_X - \mu)/\sigma$, recovering information on ω_X is straightforward.■

Under the log-normal assumption, one can decompose the role of selection into export markets into two terms. Parameter σ relates to heterogeneity in the productivity distribution, and parameter ω_X relates to the productivity threshold for entering export markets. Note that this is the case of Bellone et al. (2014) that is based on the log-normal assumption in comparing the productivity gap of exporters from two different countries. Our framework thus generalizes the framework developed by Bellone et al. (2014), departing from the log-normal distributional assumption. Importantly, the two terms concern different policies, the former being due to (process and product) innovation in markets, whereas the latter concerns the role of geographic, technological, cultural or even bureaucratic distance to export markets.

Important implications follow from the assumption of log-normally distributed productivity terms. Online Appendix A explores how the productivity premium P_X^w is affected by changes in the productivity export threshold ω_X and the heterogeneity parameter σ. It shows and discusses why the effect of heterogeneity σ on the export premium P_X^w is positive and why the effect of the export cutoff ω_X is U-shaped. 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 a large export premium implies that exporters are competitive on international markets.

4 Empirical Analysis

4.1 Baseline analysis: labour productivity

This section examines the empirical validity of Proposition 1. It states that our analytical framework can be applied to cross-country comparisons without directly accessing confidential firm-level data. To estimate the international exporter productivity gap P_X^b, only the industry-average productivity gap P^b, export participation rate Ω_c, and export productivity premium P_X^w of each country are needed. For manufacturing as a whole, it is relatively easy to access these data.

We focus on 11 advanced countries: Belgium, Germany, Sweden, France, Austria, the United Kingdom, Denmark, the United States, Japan, Italy and Spain. We obtain the industry-average labour productivity gap P^b from the Groningen Growth and Development Center (GGDC) Productivity Level Database. The export participation rate Ω_c and export productivity premium P_X^w come from ISGEP (2008) and Bellone et al. (2014).

Ideally, we would construct these variables using firm-level data across countries to maintain the consistency of the variables. However, firm-level data are confidential in many countries, and thus, it is not easy to apply the same criteria across countries. Therefore, this exercise may be helpful for those who are interested in the international comparison of exporters' productivity but cannot access confidential firm-level data, although the results of this exercise should be interpreted with caution.

Table 2 presents the results using equation (3). The industry-average productivity gaps P^b and the exporter productivity gaps P_X^b are measured relative to the United States. Table 2 indicates, for example, that Belgian firms are, on average, 26.4 percent more productive than their US counterparts, whereas Spanish firms are, on average, 26.9 percent less productive than US firms. Rank P^b and Rank P_X^b are the rankings of the productivity gap for all firms and that for exporters, respectively.

Three findings appear immediately. First, the exporter productivity gap for two countries does not necessarily reflect the industry-average productivity gap. For example, while French exporters are 8.4 percent less productive than US firms, the industry-average productivity for France is 7.9 percent greater than that of the US. As suggested by the fact that the export participation rate is higher in France, French firms presumably face lower trade costs than their US counterparts. This is indeed plausible, first because France is geographically located in the centre of Europe and, second, because it shares its currency with other neighbouring Eurozone countries, thereby decreasing export costs related to the use of foreign currencies.

Second, a higher export premium does not necessarily reflect greater performance in exporter productivity, as suggested by Proposition A1 in Online Appendix A. For example, the export premium for Italy is 9.7 percent, whereas that of the United States is 2.0 percent. Nevertheless, the average productivity of Italian exporters is 32.8 percent lower than that of US exporters. This pattern is due both to the higher industry-average productivity of US companies and fiercer selection into export markets due to higher trade costs in the US. This result clearly indicates that the international comparison of exporter productivity gaps is different from that of export productivity premia.

Third, use of Lemma 1 allows us to recover various international productivity gaps. For example, the performance of German exporters relative to Belgian exporters amounts to $P^b_{X,GER/US} - P^b_{X,BEL/US} = -.017 - .165 = -.182$, implying that German exporters are 18 percent less productive than their Belgian counterparts. In a similar vein, the performance of French exporters relative to Italian exporters amounts to $P^b_{X,FR/US} - P^b_{X,IT/US} = -.084 - (-.328) = +.244$, implying that French exporters are 24 percent more productive than their Italian counterparts. Through such a procedure, one can recover the relative performance of exporters for any pair of countries.

[Table 2 about here.]

We now turn to Proposition 4. Assuming no sunk cost of entering the domestic market and a log-normal productivity distribution, we can now calculate the heterogeneity parameter σ of the productivity distribution and the export threshold level for exporters $\hat{\omega}_X$. The results are presented in Table 3. In most European countries, the threshold productivity level $\hat{\omega}_X$ is lower than the average productivity P^b, which corresponds to the case of country 2 in the bottom panel of Figure 1, suggesting that European countries face lower sunk costs of entering export markets. In contrast, as in case of country 1 in the bottom panel of Figure 1, the threshold productivity levels for US and Japanese exporters are higher than the average productivity for the US and Japan, probably due to higher sunk cost of entering export markets.

Proposition A2 in Online Appendix A suggests that the magnitude of the heterogeneity parameter $\hat{\sigma}$ negatively affects the export premium, thereby indirectly affecting international comparisons of the exporter productivity gap P^b_X. Holding all else constant, we should therefore expect that countries with more dispersed distributions should exhibit a lower productivity gap for exporters. This is not supported by our data. For example, while Italy and Spain have the almost same threshold productivity level for exporters, namely -0.362 and -0.376, respectively, parameter $\hat{\sigma}$ for Italy is 50 percent larger than that of Spain. This leads to a larger exporter productivity gap for Italy than for Spain. This result raises concerns regarding the use of the Gaussian distribution as a working assumption about productivity. We will return to this issue in Subsection 4.5. In the next subsections, we test the robustness of our findings using alternative measures of productivity and of the export participation rate (Subsection 4.2), comparing the estimated exporter productivity gap $\hat{P}_X^b$ with the one obtained from firm-level data (Subsection 4.3) and analysing the incidence of the market selection mechanism on $\hat{P}_X^b$ (Subsection 4.4).

4.2 Robustness check I: Alternative measures of productivity and of the export participation rate

One may argue that TFP is a more appropriate productivity measure than labour productivity. We focus on France, Japan, the United Kingdom, and the United States, where such information is relatively easy to access. We obtain the industry-average productivity gap P^b from Ministry of Economy, Trade and Industry (METI, Table I-1-3-2).[10] The export participation rates Ω_c and export productivity premia P_X^w are obtained from Bernard et al. (2007) for the United States, from Bellone et al. (2014) for France and Japan, and from Greenaway and Kneller (2004) for the United Kingdom.

Table 4 presents the results based on TFP. Note that the ranking in the international TFP gap differs from that using the labour productivity gap. For example, while the labour productivity level for France is greater than that of the US, France's TFP is lower. This may reflect differences in working hours regulation and, primarily, differences in the productivity of capital. Turning to the exporters' TFP gap, the results confirm our previous findings with labour productivity: the rankings of exporters' TFP gap P_X^b are not always consistent with the rankings of the industry-average productivity gap P^b, and higher export premia $P_{X,c}^w$ across countries do not reflect greater exporter performance.

[Table 3 about here.]

One may also be concerned about the export participation rate. Ultimately, what matters is not so much the number of exporters but the volume of exports. Hence, rather than using the share of exporters, one should use the volume of exports relative to gross output. To address this concern, we use the share of exports to gross output Ω' in total manufacturing in 2005 obtained from the World Input–Output Database (Timmer, 2012). The result for labour productivity is presented in the upper panel of Table 5, and

[10] We rely on Ministry of Economy, Trade and Industry (METI) rather than the GGDC Productivity Level Database. The GGDC Productivity Level Database reports manufacturing productivity while excluding electrical machinery. In contrast, Ministry of Economy, Trade and Industry (METI) computes manufacturing productivity while including electrical machinery based on the GGDC Productivity Level Database.

that for TFP is in the lower panel. The results are qualitatively similar to those presented in the upper panel. Even when focusing on the volume of exports, our main message remains unchanged.

In sum, our framework seems relevant for a meta-analysis comparing the performance of exporters across countries. Even in the absence of firm-level data, there is indeed enough information in the economic literature to make comparisons. The productivity differences between exporters across any countries can be approximated using readily available figures *out there*, that is, when one obtains the industry-average productivity gap, the export participation rate, and the export productivity premia for both countries.

4.3 Robustness check II: Comparing gaps using aggregate data and firm-level data

This paper claims that one can estimate the exporters' productivity gap between any two countries without accessing firm-level confidential data. Yet in order to assess the relevance of this claim, we need to test whether the estimated gap $\hat{P}^b_X$ is actually *on target*: $\hat{P}^b_X = P^b_X$. To this end, we take advantage of the fact that we can access firm-level information for companies with at least 50 employees in both France and Japan, and compare the firm-level exporter productivity gaps from those obtained using GGDC data for year 1997.[11] Table 6 compares P^b_X obtained from firm-level data and $\hat{P}^b_X$ obtained from GGDC data. Since the gap is defined by subtracting French firms' TFP from that of Japan, a positive productivity gap indicates a productivity advantage in favour of Japan.

[Table 4 about here.]

Two findings are noteworthy. First, both exporter productivity gaps P^b_X and $\hat{P}^b_X$ exhibit the same sign in nine out of 11 industries. Hence aggregate figures provide a reasonably accurate picture of the direction of the exporter productivity advantage. The same holds for the overall productivity gap P^b and $\hat{P}^b$, where a discrepancy in the direction of the productivity advantage is found in only three industries. Second, the correlation coefficient between GGDC and firm-level figures exceeds .9 for the two comparisons concerning P^b_X and P^b. Overall, this exercise corroborates the idea the economic literature conceals valuable information about the productivity gaps across countries, either for the overall manufacturing or by industry.

[11]Not only are the French and Japanese firm-level data highly comparable with one another, but also both countries exhibit substantial trade cost differences, which enables us to identify large differences in the export behaviour of firms from the two countries. Specifically, we use firm-level data from France and Japan developed in Bellone et al. (2014). Online Appendix B provides a detailed explanation of the construction of the data, the definition of each variable and the methodology to ensure comparability across the two countries.

Nevertheless, the magnitude of the two gaps – P_X^b and $\hat{P}_X^b$ – differs significantly. In fact, the absolute value estimated $\hat{P}_X^b$ is significantly lower than that of P_X^b by an average of .2, which represents an underestimation of the actual gap of around 20 percent. In order to better understand the reasons justifying such a gap, we estimate the following simple regression $P_X^b = \alpha + \beta \hat{P}_X^b + \varepsilon$ over the 11 industries at our disposal. If the GGDC gap $\hat{P}_X^b$ is equal to the firm-level gap P_X^b , one would expect to find $\hat{\alpha} = 0$ and $\hat{\beta} = 1$. If instead $\hat{\alpha} \neq 0$, then there is a constant *bias* between P_X^b and $\hat{P}_X^b$. In the same vein, if $\hat{\beta} \neq 1$, the difference between P_X^b and $\hat{P}_X^b$ increases ($\hat{\beta} > 1$) or decreases ($\hat{\beta} < 1$) with $\hat{P}_X^b$, expressing a deviation in magnitude from P_X^b proportional to $\hat{P}_X^b$. Figure 2 displays the comparison, exhibiting the equality between P_X^b and $\hat{P}_X^b$ by a 45-degree solid line, the dashed line exhibiting the fit where $P_X^b = .148 + 1.708\hat{P}_X^b$. Figure 2 corroborates the idea that using GGDC data produces an exporter productivity gap substantially lower than the one obtained using firm-level data.

[Figure 2 about here.]

Why do we observe such differences? Our contention is threefold. First, one cannot rule out the possibility of measurement errors in the data, although we have trimmed the outliers located in the top and bottom one percent of the firm-level productivity distribution. Second, there may be differences in the subtleties of the TFP computation which may affect the P_X^b. Indeed, looking at P^b using firm level data and $\hat{P}^b$ using GGDC data, we observe a significant gap. We conjecture that this change in magnitude in the two measures is likely to explain why $\hat{\beta} > 1$, although it is hard to explain the very mechanics at work. One possible explanation is the fact that the use of firm-level data implies a wider spectrum of productivity levels, thereby inflating heterogeneity in the data, as opposed to the use of industry-level data relying on the use of a representative firm undermining heterogeneity in the data. Third, differences in data coverage between GGDC data – with no size truncation – and firm-level data (with a size truncation of 50 employees) produce a upward bias in favour of Japan when using firm level data, thereby explaining the positive $\hat{\alpha}$.

To see this, take equation (3) and apply it to the comparison between France and Japan, yielding $P_X^b = P^b + P_{X,JP}^w(1 - \Omega_{JP}) - P_{X,FR}^w(1 - \Omega_{FR})$. It is straightforward to show that $\partial P_X^b / \partial \Omega_{JP} = -P_{X,JP}^w < 0$ and $\partial P_X^b / \partial \Omega_{FR} = P_{X,FR}^w > 0$. This tells us that the exporter productivity gap P_X^b decreases when the export participation rate of Japan increases, and P_X^b increases when the export participation rate of France increases. By applying a size-threshold, one may indeed modify the export participation rates. How this influences the exporter productivity gap ultimately depends on the export participation rates Ω of the two countries.

Figure 3 displays the observed export participation rates gradually increasing the size truncation (i.e., the number of employees).[12] Recall that in our case, we observe

[12]Figure 2 indicates a generally positive, quasi-monotonic relationship between size truncation and

companies with at least 50 employees, and discard smaller firms, symbolised in the Figure by the vertical, solid line at ln(50) = 3.91. As Figure 3 clearly shows, the difference between the export participation rates between the two countries is greatest at around 50 employees, where the French participation rate exceeds 85 percent in France and reaches 28 percent in Japan. This implies that P_X^b is likely to be overestimated when applying such a size truncation to firm-level data, and that the difference between P_X^b and $\hat{P}_X^b$ is exacerbated by the 50-employee size truncation.

[Figure 3 about here.]

The conclusion of this exercise is that our estimated $\hat{P}_X^b$ is likely to be more reliable that firm level data imposing a size truncation in the measures. It corroborates the use of aggregate data which presumably covers all firms within an economy (or an industry). The caveat is that the proposed premium in the literature relies on the use of arithmetic productivity averages whereas industry-level productivity gaps produced by the GGDC database stem from aggregated output and input with a weight in favour of larger firms. Next Subsection investigates this avenue explicitly.

4.4 Robustness check III: The incidence of the market selection mechanism on the exporter productivity gap

One may be concerned that the aggregate productivity documented in the literature does not compare with the unweighted productivity average μ that we have used thus far. As discussed in Section 3.3, our framework is consistent with the weighted average productivity if equation (16) holds. However, whether this relationship actually holds is an empirical question. The contribution of the gap between the unweighted average productivity P^b and that of the covariance term $Ncov(\Delta\nu\Delta\omega)$ and the weighted average productivity gap Ψ is computed by dividing equation (15) by $\Psi_J - \Psi_F$:

$$1 = \left(\frac{P^b}{\Psi_J - \Psi_F}\right) + \left(\frac{N_J cov(\Delta\nu_J, \Delta\omega_J) - N_F cov(\Delta\nu_F, \Delta\omega_F)}{\Psi_J - \Psi_F}\right). \quad (19)$$

Because of the covariance term, the computation of equation (19) necessitates the use of firm-level data. Thus, we examine this issue by using our firm-level data from France and Japan. Table 7 reports the decomposition of weighted average productivity Ψ into the unweighted average productivity μ and the term $Ncov(\Delta\nu\Delta\omega)$, what Olley and Pakes (1996) call the covariance term. It also exhibits the number of observations

the export participation rate. But for relatively high levels of size truncation, the export participation rate decreases. Although this may seem surprising, our contention is that this is due to changes in the industry composition of the economy as the size truncation increases. By doing so, some industries are being dropped from the sample, thereby affecting the size truncation-export participation rate non-monotonically.

N for both countries, the differences in Ψ and in μ, and the contributions of both μ and the covariance term to the weighted average productivity gap $\Psi_J - \Psi_F$.

[Table 5 about here.]

Three findings are notable. First, the covariance terms $Ncov(\Delta v, \Delta\omega)$ in France and Japan are not negligibly small. Industry structures (N) and the size productivity advantage $cov(\Delta v, \Delta\omega)$ account for less than 10 percent of the aggregate productivity. The unreported Student t-tests of equality of the covariance terms between the two countries reveal that the means are significantly different between the two countries for all industries. This suggests that the nature of competition is country-specific.

Second, the difference in the productivity premium in size $cov(\Delta v \Delta\omega)$ between France and Japan is relatively small, and the unreported Student t-test reveals no significant differences in the covariance terms. This implies that the difference in the covariance term comes essentially, if not exclusively, from the difference in the number of firms N, that is, differences in industry structures between the two countries. The fact that the size advantage does not appear to be significantly different between the two countries may come as a surprise. The rise and growth of the Japanese economy was initially export driven, based on the capacity of few yet remarkably successful companies in gaining international market shares. This relatively accepted story could produce results whereby Japanese companies should enjoy a larger size advantage. A more detailed observation of the covariance term shows that in 14 industries, the covariance term is larger in Japan. Whether these differences are statistically significant is one issue. Economically, however, they suggest that, indeed, Japanese companies have been more successful at exploiting economies of scale than their French counterparts.

Third, the contribution of the covariance term $Ncov(\Delta v \Delta\omega)$ to the aggregate productivity gap is rather small for most industries when the productivity gap between the two countries is large. This is mainly due to differences in technologies μ. When the gap is small, the role played by differences in the nature of competition mechanically inflates, as is the case for *Fabricated metal prod* and in *Machinery & equip* industries. This is why in *All Manufacturing* the contribution of the covariance term is relatively large, amounting to 72 percent. This is because the performance of countries in manufacturing conceals important sectoral specialization where productivity differentials are more pronounced. It also implies that sector specialization should be taken into account when comparing the productivity performance of countries.

Finally, in all sectors and for both countries, the market selection mechanism seems to operate in conformity with what economic theory tells us: firms with higher productivity levels enjoy larger market shares. Allocative efficiency seems to perform better in Japan for all manufacturing. Yet this overall difference conceals sector-specific differences that are much larger in magnitude. We do not observe any specific link between profit opportunities for domestic firms and a productivity advantage. Again, this corroborates the idea that allocative efficiency reflects more institutional aspects of the functioning of markets that cannot be reflected in a simple productivity term.

4.5 Additional findings assuming – and testing – the log-normal distribution of firm-level total factor productivity

In Subsection 4.1, assuming no sunk cost of entering the domestic market and a log-normal productivity distribution, we estimated the standard deviation of productivity distribution $\hat{\sigma}$ and the threshold productivity level $\hat{\omega}_X$ (see Table 3). However, whether the estimated productivity follows the normal distribution is not guaranteed. In this Subsection, we assume that both distribution re log-normal and derive measures of $\hat{\sigma}$ to compare it with the observe σ using the firm-level data. Table 8 displays the results.[13]

We have two remarks. First, the TFP threshold for French exporters is not always lower than that for Japan. This is surprising given the higher participation rate for French firms and the magnitude of the gap in the participation rate between the two countries. In industries such as *Printing & publishing*, *Chemical prod*, *Rubber & plastic*, *Non-metallic mineral prod*, *Machinery & equip* and *Furnitures & other mfg*, the estimated TFP threshold $\hat{\omega}_X$ for French exporters is actually larger than that for Japanese exporters. In these industries, the French average productivity for all firms is higher than that of Japanese firms, which drives up the TFP threshold for French exporters.

[Table 6 about here.]

Second, parameter $\hat{\sigma}$ is much larger than the observed σ. Although both are correlated,[14] $\hat{\sigma}$ significantly underestimates σ, casting doubt on the log-normal assumption of the productivity distribution. Why are our estimates systematically smaller than the actual ones? And why does the normal assumption perform so poorly? If the actual productivity distribution has longer tail than the normal distribution, $\hat{\sigma}$ under the normality assumption will systematically underestimates actual σ. Figure 4 displays the two empirical firm-level productivity distributions for both Japan and France. Although it appears that the distributions are monomodal, the Kolmogorov-Smirnov test rejects the null hypothesis that the two distributions are distributed log-normal. In fact, both distributions appear to be leptokurtic, pointing to the presence of heavy tails.[15]

[Figure 4 about here.]

[13] In some industries, the parameters $\hat{\sigma}$ and $\hat{\omega}_X$ are missing because the export premium P_X^w is negative, which is not consistent with our framework.

[14] The correlation indices between them are 0.47 and 0.71 for France and Japan, respectively.

[15] There are several leptokurtic distributions. Examples include the Student t-distribution and Laplace distribution, which have longer tails than the normal distribution.

Finally, recall that Proposition A2 states that a more heterogeneous distribution equates to a higher export premium $P^w_{X,c}$. In fact, this is strongly corroborated by our data. The correlation coefficient between σ and $P^w_{X,c}$ amounts to .56 for France and .73 for Japan. A simple simulation of equation (A3) for various values of parameters σ and ω_X reveals a correlation coefficient between P^w_X and σ exceeding .7, that is, similar to what we observe in the case of Japan and, to a lesser extent, France. These findings corroborate the use of log-normally distributed productivity terms as a reasonable working assumption in international trade models at the expense of the alternative Pareto-distributed working assumption as in Melitz and Ottaviano (2008), although the log-normal distribution violates the empirical productivity heterogeneity found in the data.

5 Conclusion

Social scientists increasingly rely on the use of confidential data on individual companies or employees, and rightly so. For example, in the realm of economics, increased reliance on firm-level information has produced a series of results across countries and industries regarding the export behaviour of companies that are readily available to all economists. However, this information is generally dispersed, difficult to compare and conceals differences in data generating processes that reflect differences in country-specific institutions. These caveats often cast doubt on the comparability of such simple statistics across countries.

This paper stems from the intuition that under specific yet generally satisfied conditions, such comparisons can be performed. Importantly, such statistics can be used to infer additional features, notably that of the cross-country exporter productivity gap. Our simple framework allows for the computation of the cross-country exporter productivity gap without directly accessing confidential firm-level data. We have shown that the average international productivity gap between exporters depends on the three sufficient statistics: 1) the industry-average productivity gap between two countries, 2) export participation rate, and 3) export premia. Assuming no sunk cost of entering the domestic market and the log-normal productivity distribution, we can infer the heterogeneity parameter of the productivity distribution $\hat{\sigma}$ and the threshold productivity level $\hat{\omega}_X$ above which firms can enter to international markets.

We applied our framework to cross-country comparisons across 11 advanced countries such as Japan, the United Kingdom, and the United States. We found that the average exporter productivity gap between two countries does not necessarily reflect the industry-average productivity gap, due to the differences in export participation rates and export premia across countries. Our simple framework performs well with the use of such readily available information and is robust to various measures of productivity and alternative definitions of the export participation rate. Our methodology relies on the assumption that the differences in allocative efficiency, namely the product of competition and the expected gains in market shares stemming form productivity growth, are small. However when the productivity gap between two countries is large, differences in allocative efficiency do not matter, as the estimated σ within our framework significantly underestimates the observed heterogeneity parameter. This is probably due to the leptokurtic distributions. Altogether, these results suggest that, while caution is needed, our framework is useful as a first approximation.

Greater access to detailed information can help social scientists to depict new causalities. However, our experience also tells us that the use of large databases entails important computational costs. One should not ignore the alternative possibility of deriving additional stylized facts from simple, existing information. This paper is a first step towards such a research strategy. We believe that our framework can be extended to various other issues, such as, the analysis of international wage or price differentials that may help to explain the international allocation of resources.

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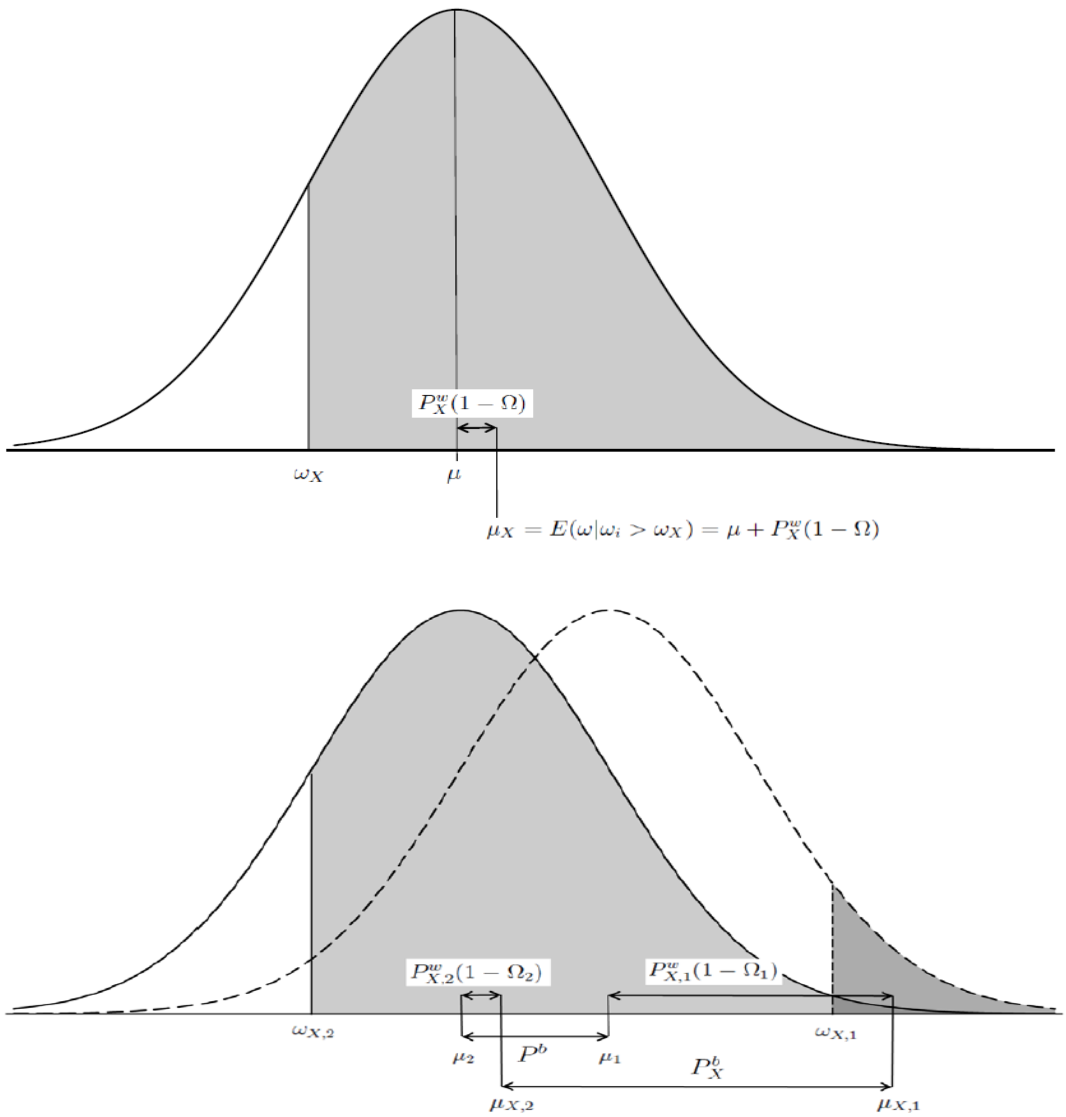
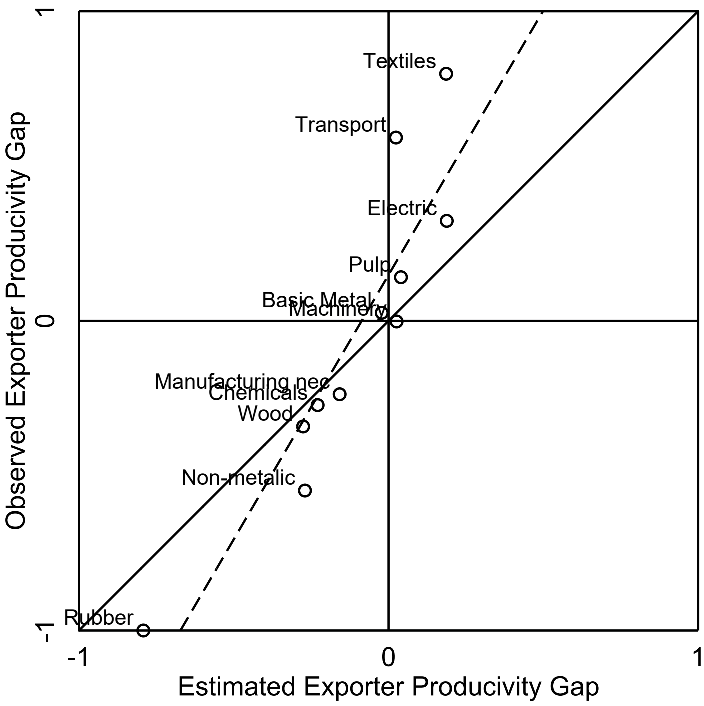
Figure 1: Exporter Productivity Gaps as a Function of the Export Threshold value



Notes: Dashed line = Country 1; solid line = Country 2.

Figure 2: Observed and Estimated Productivity Gaps P_X^b and $\hat{P}_X^b$ between France and Japan

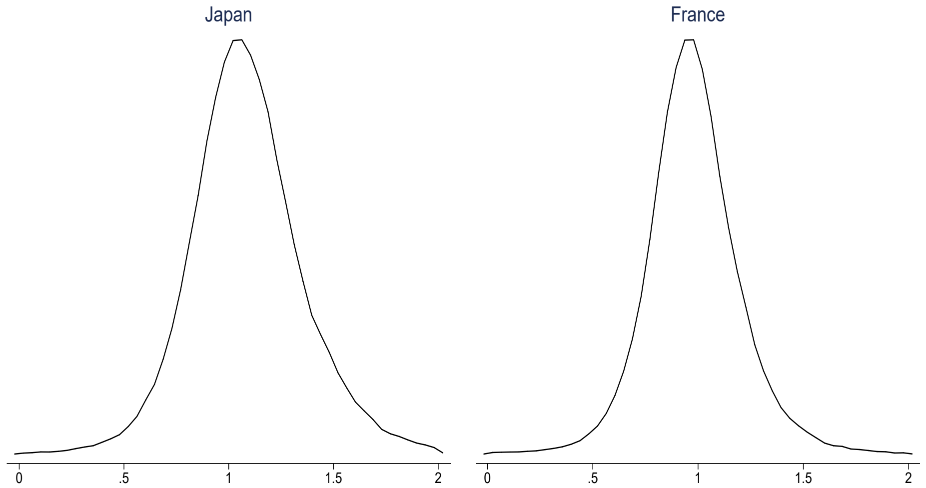


Notes: The dashed line represents predictions from the regression $P_X^b = \alpha + \beta \hat{P}_X^b + \varepsilon$, where $\hat{\alpha} = .148$ and $\hat{\beta} = 1.708$, with respective p-values $p_\alpha = .072$ and $p_\beta = .000$. Adjusted $R^2 = .819$ and $N = 11$ industries.

Figure 3: Export Participation Rates for France (dashed line) and Japan (solid line)

Notes: Based on our appreciative knowledge, we arbitrarily set the export participation rate for all firms to 5% in France and 1% in Japan. Values for France for firms with less than 50 employees are obtained from FICUS data. In the case of Japanese firms with less than 50 employees, we use a log-linear approximation of the relationship between size truncation and export participation rate. The vertical, solid line indicates the size truncation of 50 employees (ln(50) = 3.91) used in the firm-level analysis.
Sources: Firm-level data obtained from national statistical offices for Japan and France.

Figure 4: Empirical TFP distributions for Japan and France



Notes: Firm-level data obtained from national statistical offices for Japan and France. All observations are net from industry×year specific effects.
Sources: Firm-level data obtained from national statistical offices for Japan and France.

Table 1: Ranking of Labour Productivity Relative to the US for the year 2005

	P^b	Rank P^b
Belgium	0.264	1
Germany (W Germany)	0.149	2
Sweden	0.139	3
France	0.079	4
Austria	0.073	5
United Kingdom	0.067	6
Denmark	0.066	7
United States	0.000	8
Japan	-0.180	9
Italy	-0.239	10
Spain	-0.268	11

Notes: Labour productivity is measured by value added per hours worked. P^b is the industry-average labour productivity gap, based on year 2005 PPP, relative to the United States.
Source: P^b is obtained from the GGDC Productivity Level Database

Table 2: Productivity of Exporters: Labour Productivity

	P^b	Ω	P_X^w	P_X^b	Rank P^b	Rank P_X^b
Belgium	0.264	0.803	0.578	0.165	1	1
Germany (W Germany)	0.149	0.693	0.154	-0.017	2	3
Sweden	0.139	0.830	0.067	-0.063	3	5
France	0.079	0.748	0.200	-0.084	4	6
Austria	0.073	0.714	0.175	-0.090	5	7
United Kingdom	0.067	0.695	0.099	-0.116	6	8
Denmark	0.066	0.772	0.385	-0.059	7	4
United States	0.000	0.180	0.260	0.000	8	2
Japan	-0.180	0.275	0.210	-0.241	9	9
Italy	-0.239	0.693	0.403	-0.328	10	10
Spain	-0.268	0.747	0.275	-0.412	11	11

Notes: P^b is the industry-average productivity gap, based on year 2005 PPP, relative to the United States; Ω is the ratio of the number of exporters to the total number of firms; P_X^w is the export productivity premium; and P_X^b is the productivity gap between exporters across countries. P_X^b is obtained from equation (3): $P_X^b = P^b + P_{X,c}^w(1-\Omega_c) - P_{X,US}^w(1-\Omega_{US})$.
Sources: P^b is obtained from the GGDC Productivity Level Database

Table 3: Competitiveness, Firm Heterogeneity, and Export Threshold Productivity

	P_X^b	P^b	$\hat{\sigma}$	$\lambda(z_X)$	$\hat{\omega}_X$
Belgium	0.165	0.264	0.330	0.345	-0.017
Germany (West Germany)	-0.017	0.149	0.093	0.507	0.102
Sweden	-0.063	0.139	0.037	0.305	0.103
France	-0.084	0.079	0.118	0.427	0.000
Austria	-0.090	0.073	0.105	0.476	0.014
United Kingdom	-0.116	0.067	0.060	0.504	0.037
Denmark	-0.059	0.066	0.224	0.391	-0.101
United States	0.000	0.000	0.146	1.458	0.134
Japan	-0.241	-0.180	0.125	1.213	-0.105
Italy	-0.328	-0.239	0.244	0.507	-0.362
Spain	-0.412	-0.268	0.163	0.428	-0.376

Table 4: Productivity of Exporters: Total Factor Productivity (TFP)

	P^b	Ω	P_X^w	P_X^b	Rank P^b	Rank P_X^b
United States	0.000	0.180	0.020	0.000	1	1
France	-0.104	0.748	0.014	-0.117	2	4
United Kingdom	-0.110	0.695	0.097	-0.097	3	2
Japan	-0.139	0.275	0.056	-0.115	4	3

Notes: P^b is the industry-average TFP gap, based on year 2005 PPP, relative to the United States; Ω is the ratio of the number of exporters to the total number of firms; P_X^w represents the export productivity premia; and P_X^b is the productivity gap between exporters across countries. P_X^b is obtained from equation (3): $P_X^b = P^b + P_{X,c}^w(1-\Omega_c) - P_{X,US}^w(1-\Omega_{US})$.
Sources: See main text.

Table 5: Alternative measure of export participation rate

	P^b	Ω	P_X^w	P_X^b	Rank P^b	Rank P_X^b
United States	0.000	0.180	0.020	0.000	1	1
France	-0.104	0.748	0.014	-0.117	2	4
United Kingdom	-0.110	0.695	0.097	-0.097	3	2
Japan	-0.139	0.275	0.056	-0.115	4	3
	P^b	Ω'	P_X^w	P_X^b	Rank P^b	Rank P_X^b
United States	0.000	0.151	0.020	0.000	1	1
France	-0.104	0.422	0.014	-0.113	2	4
United Kingdom	-0.110	0.420	0.097	-0.071	3	2
Japan	-0.139	0.187	0.056	-0.110	4	3

Notes: This table uses an alternative measure of the export participation rate. Ω' is the ratio of exports to gross output.
Sources: See main text.

Table 6: Productivity of Exporters: Firm-level Analysis for France and Japan

	France-Japan firm-level data						GGDC	
	France		Japan		Japan-France			
GGDC industries	Ω	P_X^w	Ω	P_X^w	P^b	P_X^b	$\hat{P}^b$	$\hat{P}_X^b$
Textiles, textile products, leather & footwear	0.797	0.019	0.099	0.103	0.709	0.798	0.097	0.186
Wood & products of wood & cork	0.730	-0.027	0.064	0.030	-0.376	-0.341	-0.311	-0.276
Pulp, paper, paper products, printing & publishing	0.785	-0.024	0.066	0.041	0.100	0.141	-0.003	0.040
Chemicals & chemical products	0.942	0.006	0.458	0.047	-0.297	-0.272	-0.254	-0.229
Rubber & plastics products	0.857	0.045	0.245	0.041	-1.064	-1.039	-0.816	-0.792
Other non-metallic mineral products	0.868	0.007	0.212	0.039	-0.004	0.026	-0.287	-0.270
Basic metals & fabricated metal products	0.760	0.042	0.187	0.033	-0.565	-0.548	-0.052	-0.022
Machinery, nec	0.886	0.007	0.454	0.050	-0.028	-0.002	0.000	0.026
Transport equipment	0.911	0.009	0.271	0.050	0.556	0.592	-0.012	0.024
Electrical & optical equipment	0.873	0.044	0.390	0.070	0.288	0.323	0.152	0.188
Manufacturingnec; recycling	0.927	0.023	0.291	0.048	-0.270	-0.237	-0.190	-0.158

Notes: The comparison pertains to year 1997 only, and covers 11 industries only, due to the adequacy of the industry breakdown between GGDC data and the national statistical offices.

Sources: Firm-level data obtained from national statistical offices for Japan and France.

Table 7: Decomposition of the Weighted Average Productivity Gap Between France and Japan

Industry	Ψ_{FR}	Ψ_{JP}	μ_{FR}	μ_{JP}	OP_{FR}	OP_{JP}	N_{FR}	N_{JP}	cov_{FR}	cov_{JP}	$Diff_{\Psi}$	$Diff_{\mu}$	$Cont_{\mu}$	$Cont_{cov}$
All manufacturing	1.109	1.162	1.034	1.049	0.075	0.113	85,848	87,406	0.9	1.3	0.053	0.015	0.275	0.725
Textile	0.645	1.37	0.599	1.321	0.046	0.049	4,890	2,715	9.4	18.0	0.725	0.721	0.995	0.005
Clothing	0.727	1.375	0.626	1.248	0.101	0.127	5,377	2,695	18.8	47.1	0.648	0.622	0.961	0.039
Manufacture of wood	1.203	0.832	1.190	0.783	0.012	0.049	2,183	1,128	5.5	43.4	-0.371	-0.407	1.098	-0.098
Pulp & paper	0.942	1.161	0.903	1.081	0.039	0.080	3,396	3,294	11.5	24.3	0.220	0.178	0.811	0.189
Printing & publishing	1.128	1.088	1.006	0.959	0.122	0.129	5,565	6,034	21.9	21.4	-0.040	-0.047	1.169	-0.169
Chemical prod	1.317	1.020	1.198	0.910	0.119	0.110	7,516	7,571	15.8	14.5	-0.297	-0.288	0.969	0.031
Rubber & plastic	1.619	0.579	1.580	0.494	0.039	0.085	7,248	5,383	5.4	15.8	-1.040	-1.085	1.044	-0.044
Non-metallic mineral prod	1.399	0.815	1.278	0.732	0.121	0.083	3,891	4,398	31.1	18.9	-0.584	-0.546	0.935	0.065
Basic metal prod	0.998	1.104	0.949	1.025	0.049	0.079	3,151	5,910	15.6	13.4	0.106	0.076	0.717	0.283
Fabricated metal prod	1.062	1.029	1.039	0.956	0.023	0.074	10,960	7,715	2.1	9.6	-0.033	-0.084	2.536	-1.536
Machinery & equip	1.102	1.103	1.047	1.002	0.055	0.100	11,237	10,840	4.9	9.2	0.001	-0.045	$-\infty$	$+\infty$
Machinery for office	1.044	1.537	0.929	1.398	0.116	0.139	340	1,245	341.2	111.6	0.493	0.470	0.953	0.047
Electric machinery	1.030	1.427	0.963	1.288	0.067	0.139	5,653	10,463	11.9	13.3	0.397	0.326	0.819	0.181
Communication equip	1.331	1.500	1.205	1.340	0.126	0.161	1,128	1,798	111.7	89.5	0.169	0.135	0.796	0.204
Medical & precision inst	1.068	1.383	0.950	1.269	0.118	0.114	3,822	4,106	30.9	27.8	0.315	0.319	1.015	-0.015
Motor vehicles	0.716	1.437	0.689	1.324	0.027	0.113	2,945	7,210	9.2	15.7	0.721	0.634	0.881	0.119
Other transport equip	0.812	1.337	0.683	1.242	0.129	0.095	1,765	1,730	73.1	54.9	0.525	0.559	1.065	-0.065
Furnitures & other mfg	1.225	1.076	1.181	0.905	0.043	0.171	4,781	3,171	9.0	53.9	-0.148	-0.276	1.861	-0.861

Notes: the figures are the averages across years. *OP* stands for the Olley and Pakes covariance term measuring allocative efficiency, while *cov* stands for the covariance measuring the expected gains in market share ($\times 10^6$) for a one-unit increase in productive efficiency. Contributions were computed using equation (19). See also the footnote to Table 6 for the computation of sector averages. Sources: Firm-level data obtained from national statistical offices for Japan and France.

Table 8: Estimated Productivity Distribution $\hat{\sigma}$ and the Threshold Productivity Level for Exporters $\hat{\omega}_X$

	P_X^b	P^b	France			Japan		
			σ	$\hat{\sigma}$	$\hat{\omega}_X$	σ	$\hat{\sigma}$	$\hat{\omega}_X$
Industry								
All manufacturing	0.046	0.015	0.137	0.009	1.024	0.124	0.030	1.063
Textile	0.772	0.721	0.122	0.013	0.584	0.134	0.037	1.354
Clothing	0.725	0.622	0.148	0.026	0.606	0.178	0.062	1.333
Manufacture of wood	-0.386	-0.407	0.105			0.095	0.010	0.797
Pulp & paper	0.211	0.178	0.115			0.094	0.018	1.104
Printing & publishing	-0.014	-0.047	0.181	0.003	1.005	0.142	0.018	0.986
Chemical prod	-0.264	-0.288	0.161	0.009	1.184	0.127	0.031	0.910
Rubber & plastic	-1.055	-1.085	0.105	0.012	1.565	0.086	0.027	0.510
Non-metallic mineral prod	-0.504	-0.546	0.139	0.014	1.268	0.117	0.035	0.761
Basic metal prod	0.100	0.076	0.108	0.006	0.939	0.107	0.020	1.037
Fabricated metal prod	-0.066	-0.084	0.117			0.116	0.013	0.965
Machinery & equip	-0.018	-0.045	0.133	0.007	1.039	0.119	0.035	1.003
Machinery for office	0.535	0.470	0.148	0.015	0.902	0.139	0.065	1.420
Electric machinery	0.364	0.326	0.166	0.022	0.936	0.165	0.043	1.302
Communication equip	0.183	0.135	0.205	0.028	1.185	0.194	0.057	1.361
Medical & precision inst	0.345	0.319	0.165	0.007	0.940	0.144	0.038	1.264
Motor vehicles	0.665	0.634	0.123	0.017	0.664	0.093	0.029	1.338
Other transport equip	0.600	0.559	0.238	0.030	0.649	0.117	0.045	1.260
Furnitures & other mfg	-0.219	-0.276	0.124	0.022	1.150	0.151	0.053	0.932

Notes: parameter σ is the observed standard deviation of the TFP distribution. Parameter $\hat{\sigma}$ is our estimate derived from our framework. We did not compute $\hat{\sigma}$ and $\hat{\omega}_X$ when $P_X^w < 0$ because it is inconsistent with our framework. See also the footnote to Table 6 for the computation of sector averages.

Sources: Firm-level data obtained from national statistical offices for Japan and France.

Appendix A. On the role of the export cutoff ω_X and heterogeneity σ on the productivity premium under the log-normal assumption

This appendix analyses the effect of the export cutoff ω_X and heterogeneity σ on the productivity premium under the log-normal assumption.

Under perfect sorting, all firms exceeding the country-specific, productivity threshold value ω_{cX} manage to export, whereas firms failing to reach the threshold 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:

$$\mu_X = \mu + \sigma \frac{\phi(z)}{1-\Phi(z)}, \tag{A1}$$

and

$$\mu_D = \mu - \sigma \frac{\phi(z)}{\Phi(z)}, \tag{A2}$$

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. Hence $z = z_X$, and we abstract from subscript X for the sake of clarity. The productivity export premium P_X^w, defined as the difference between the mean level of productivity of exporters and that of non exporters within a country, reads:

$$P_X^w = \sigma \frac{\phi(z)}{[1-\Phi(z)]\Phi(z)}. \tag{A3}$$

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

Proposition A1: *The effect of export cutoff ω_X on the productivity export premium P_X^w is non linear. When P_X^w is lower than the average productivity level of the industry μ, an increase in ω_X decreases the productivity export premium P_X^w. When P_X^w is higher than the average productivity level of the industry μ, an increase in ω_X increases the productivity export premium P_X^w.*

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

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

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

$$\frac{\partial P_X^w}{\partial z} = \sigma \frac{-z\phi(z)(1-\Phi(z))\Phi(z) - \phi(z)^2[1-2\Phi(z)]}{\left[(1-\Phi(z))\Phi(z)\right]^2}. \tag{A4}$$

We know that both σ and the denominator, because of the squared term, are always positive, so that the sign of equation (A4) depends ultimately on 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:

$$\frac{\mathrm{d}}{\mathrm{d}z} P_X^w > 0 \quad \text{iif} \quad z < \frac{\phi(z)}{1-\Phi(z)} \cdot \left[2 - \frac{1}{\Phi(z)}\right]. \tag{A5}$$

A simple numerical application shows that condition (A5) holds so long as $z > 0$. Therefore, $\partial P_X^w/\partial z > 0 \quad \forall z \in \Re^+$, $\partial P_X^w/\partial z = 0$ if $z = 0$, $\partial P_X^w/\partial z < 0 \quad \forall z \in \Re^-$.

It is straightforward to show that $\partial z/\partial \omega_X = 1/\sigma$, which is always positive. Table A1 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 A1: How the export cutoff ω_X affects the export premium

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

Proposition A1 says that the magnitude of the export premium is partly determined by the export participation rate: high premia come from an export threshold 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.

In a similar fashion, we propose:

Proposition A2: *The effect of heterogeneity σ on the productivity export premium P_X^w is positive.*

Proof: From equation (A3), let $u = \sigma$ and $v(z) = \phi(z)/[(1-\Phi(z))\Phi(z)]$. We can therefore write:

$$\frac{\partial P_X^w}{\partial \sigma} = u'v + uv' \quad \text{(A6)}$$

$$= v(z) + \sigma \frac{\partial v(z)}{\partial \sigma}. \quad \text{(A7)}$$

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

$$\sigma \frac{\partial v(z)}{\partial \sigma} = \sigma \frac{\partial v(z)}{\partial z}\frac{\partial z}{\partial \sigma} \quad \text{(A8)}$$

$$= \sigma \frac{-z\phi(z)(1-\Phi(z))\Phi(z) - \phi(z)^2[1-2\Phi(z)]}{\left[(1-\Phi(z))\Phi(z)\right]^2} \cdot \left(\frac{-z}{\sigma}\right) \quad \text{(A9)}$$

$$= z\frac{z\phi(z)(1-\Phi(z))\Phi(z) + \phi(z)^2[1-2\Phi(z)]}{\left[(1-\Phi(z))\Phi(z)\right]^2}. \quad \text{(A10)}$$

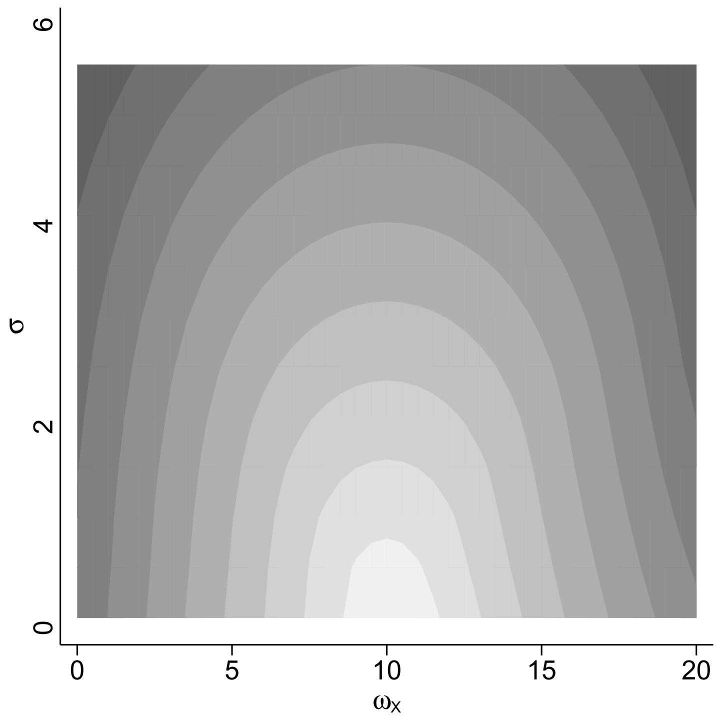
Therefore,

$$\frac{\partial P_X^w}{\partial \sigma} = \frac{\phi(z)}{[1-\Phi(z)]\Phi(z)} + z\left(\frac{z\phi(z)(1-\Phi(z))\Phi(z) + \phi(z)^2[1-2\Phi(z)]}{\left[(1-\Phi(z))\Phi(z)\right]^2}\right). \quad \text{(A11)}$$

The first term in the RHS of equation (A11) $\frac{\phi(z)}{[1-\Phi(z)]\Phi(z)}$ is always positive. This is less clear fr 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 (A5), 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 $\frac{\partial P_X^w}{\partial \sigma} > 0 \quad \forall z \in \Re$.■

That the effect of heterogeneity in firm productivity on the premium is negative may seem counterintuitive. One could argue that more dispersion implies a larger magnitude in differences across firms. Under perfect sorting, this could mechanically increase the productivity gap between exporters and non exporters. In fact, this positive effect appears in equation (A3) as the first RHS term. But an increase in σ mechanically decreases z and translates in a decrease in the range of the support of the standard normal distribution. Because the support spreads over a smaller segment of the z distribution, the export premium P_X^w mechanically decreases. Overall, this exercise shows us that the latter effect dominates the former effect in all circumstances. An important implication of Proposition A2 is that cross-country differences in export premia may stem from differences in the heterogeneity terms of the distribution.

Figure A1. Export Productivity Threshold ω_X, Heterogeneity σ and the Export Premium $P_{X,c}^w$



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

Figure A1 corroborates the Proofs, and shows how the export premium $P_{X,c}^w$ is affected by the export cutoff ω_X and 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.

Appendix B. Sources of firm-level data and construction of variable

The French and Japanese firm-level data used in this study were collected by their respective national statistical offices. Both the French and Japanese firm-level data used in this study were collected by national statistical offices. Data for France were drawn from the confidential *Enquête Annuelle d'Entreprises* (*EAE*) jointly prepared by the Research and Statistics Department of the French Ministry of Industry (SESSI) and the INSEE. This survey was conducted annually from 1984 until 2007. It gathers information from the financial statements and balance sheets of individual manufacturing firms and includes all of the relevant information to compute productivity indices and information on the international activities of the firms surveyed.

Data for Japan were drawn from the confidential micro-level database of the *Kigyou Katsudou Kihon Chousa Houkokusho* (*Basic Survey of Japanese Business Structure and Activities*: *BSJBSA*) prepared annually by the Research and Statistics Department, METI (1994–2006). This survey was first conducted in 1991 and then annually from 1994. The main purpose of the survey is to statistically capture the overall picture of Japanese corporate firms in light of their activities in diversification, globalization, and strategies for R&D and information technology.

France and Japan conduct very similar types of firm-level surveys, thus allowing us to build a relevant set of comparable variables for the TFP computations using firm-level information: nominal output and input variables, industry-level data for price indices, hours worked, and depreciation rates.[16] The data-implementation step allows us to construct two separate, unbalanced panel datasets with the same coverage: the same period (1994–2006), the same industries, the same employment threshold (over 50 employees), and the same definition of inputs and output to estimate the production function.[17] To convert the input and output series in France and Japan into common units, we use the industry-specific PPP series from the GGDC Productivity Level Database, which provides comparisons of output, inputs, and productivity at a detailed industry level for a set of 30 OECD countries.[18]

Our baseline estimation of TFP is calculated by the index approach, which is consistent with that in GGDC database.[19] To compare firm-level productivity levels from two different countries, the vectors of inputs and output of firms must be directly com-

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[16] Because of the high comparability of the firm-level data in Japan and France, a recent international comparative study by Dobbelaere et al. (2015) also used the *EAE* and the *BSJBSA* data.

[17] Our data cover the period 1995–2006 because the variables in 1994 are used only for lagged variables in the estimation.

[18] See Inklaar and Timmer (2008) for a comprehensive description of the database and the methodology followed to construct the PPP series.

[19] We also estimate TFP based on a production function developed by Wooldridge (2009) and Blundel and Bond (2000), which confirms the robustness of our findings. These results are available from the authors upon request.

parable.[20]

Output is defined as total nominal sales deflated using the industry-level gross output price indices drawn from *INSEE* for France and from the Japan Industrial Productivity (JIP) 2009 database for Japan.[21]

Labour input is obtained by multiplying the number of employees by the average hours worked by industry. Industry-level hours worked data are drawn from the EU-KLEMS dataset of the GGDC for France and from the JIP 2009 database for Japan.[22] Note that in France, a large decline in hours worked occurred from 1999 onwards because of the 35-hour/week policy: worked hours fell from 38.39 in 1999 to 36.87 in 2000.

The variables for intermediate inputs are available in both the *EAE* and *BSJBSA* surveys. In both surveys, intermediate inputs are defined as operating cost (= sales cost + administrative cost) − (wage payments + depreciation cost). The inputs are deflated using the industry price indices for intermediate inputs published by *INSEE* for France and by the JIP 2009 database for Japan.

The capital stocks are computed from investments and book values of tangible assets following the traditional perpetual inventory method (the industry subscript j and country superscript c are discarded to simplify the notation):

$$K_{it} = K_{it-1}(1-\delta_{t-1}) + I_{it}/p_{It}, \tag{1}$$

where K_{it} is the capital stock for firm i operating in year t; δ_{t-1} is the depreciation rate in year $t-1$; I_{it} is the investment of firm i in year t;[23] and p_{It} is the investment goods deflator for industry j.[24] Both investment price indices and the depreciation rates are available at the two-digit industrial classification level. They are drawn from the JIP 2009 database for Japan and from the INSEE series for France. The investment flows are traced back to 1994 for the incumbent firms and back to the entry of the firm into our dataset for the firms that entered our dataset after 1994.

The cost of intermediate inputs is defined as the nominal cost of intermediate inputs, while that of labour is the wage payments. To compute the user cost of capital (i.e., the rental price of capital) in country c, we use the familiar cost-of-capital equation given by Jorgenson and Griliches (1967) (the industry subscript j and country superscript c

[20]We exclude outliers from the data used in Bellone et al. (2014). Specifically, we exclude firms with logs of outputs and inputs in the bottom 1 percent.

[21]The JIP database was compiled as a part of a research project by the Research Institute of Economy, Trade, and Industry (RIETI) and Hitotsubashi University. For further details about the JIP database, see Fukao et al. (2007).

[22]The concordance between the industry-level EU-KLEMS database and the firm-level *EAE* database is achieved through the use of ISIC codes.

[23]Investment data are not available in the *BSJBSA*. We thus use the difference in nominal tangible assets between two consecutive years as a proxy for nominal investment.

[24]If firm i's investment was missing in year t, we consider firm i as having made no investment: $I_{it} = 0$.

are discarded to simplify the notation):[25]

$$p_{Kt} = p_{It-1}\tilde{p}_{Kt} + \delta_t p_{It} - (p_{It} - p_{It-1}). \tag{2}$$

This formula shows that the rental price of capital p_{Kt} is determined by the nominal rate of return ($\tilde{p}_{Kt}$), the rate of economic depreciation and capital gains. The capital revaluation term can be derived from investment price indices. To minimize the impact of sometimes volatile annual changes, three-period annual moving averages are used. The nominal rates of return are yields on 10-year government bonds of France and Japan.

[25]Ideally, this equation would be augmented to take into account business income tax. However, as taxation regimes differ between France and Japan, we prefer, as in Inklaar and Timmer (2008), to rely on a simpler common formula abstracting from taxation

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