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Flora BELLONE
University of Nice Sophia-Antipolis and GREDEG

KIYOTA Kozo
RIETI

MATSUURA Toshiyuki
Keio University

Patrick MUSSO
University of Nice Sophia-Antipolis and GREDEG

Lionel NESTA
Observatoire Français des Conjonctures Economiques (OFCE)

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Abstract

This paper provides new evidence on the international productivity gaps; this evidence is built from large scale firm-level data from the French and Japanese manufacturing industries. Our primary finding is that international productivity gaps are sensitive to the export status of firms. We establish that the productivity gap between French and Japanese exporters differs systematically from the average industry gap—this gap is *wider* in the industries in which Japan has a productivity lead and *narrower* in the industries in which France has a productivity lead. We relate this basic finding to the new models of international trade with heterogeneous firms. Under this framework, our data predict that Japanese firms, on average, face higher trade costs than French firms.

Keywords: International productivity gap; Exports; Firm heterogeneity; Trade costs; Productivity distribution
JEL classification: F1, D24

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1 Introduction

Are international productivity gaps sensitive to the export status of firms? Answering this question is not a straightforward exercise. On the empirical side, an answer requires the ability to compute reliable productivity estimates at the firm level that are directly comparable across countries. This methodological challenge is serious enough to make international productivity comparisons built from firm-level data still very scarce in the literature. On the theoretical side, whereas it is well established that a firm's relative productivity is related to its export status *within* a country-industry, it is less obvious how this property expands to cross-country within-industry comparisons. Assume that countries differ both in terms of their relative firm productivity distributions and in terms of their relative trade costs. Should we expect any systematic patterns in terms of the productivity gaps across exporters (or non-exporters) from two different countries within the same industry?

In this paper, we make the following three contributions. First, we propose an empirical strategy that allows the comparison of reliable firm-level total factor productivity (TFP) indexes from large scale firm-level datasets (for which confidentiality restrictions apply). Second, we reveal that a systematic pattern does indeed exist that relates the productivity gaps between French and Japanese firms to their export status. We show that the productivity gap between French and Japanese exporters is *larger* than the average industry gap in the industries in which Japan has a productivity advantage over France and *smaller* than the average industry gap in the industries in which Japan has a productivity disadvantage compared to France. Third, we provide a simple framework to connect this basic finding to the recent models of international trade and heterogeneous firms.

Our motivation for this research comes from two strands of the literature. The first strand is the literature on international productivity gaps, which is of central interest in various research fields such as industrial organisation and growth theory.[1] Numerous studies have attempted to measure international productivity gaps, relying on country-, industry-, or firm-level data sets. Baily and Solow (2001) in particular emphasised the importance of international productivity comparisons at the firm level. However, international productivity comparisons built from firm-level data have remained scarce and limited in scope. Some of the previous studies have focused only on the *average* productivity of firms.[2] Some of the studies have focused only on large listed firms, precluding the ability to address the issue of firm export heterogeneity because most of the listed firms are exporters.[3] Only a few of the previous studies have provided comparisons of the entire distributions of firm productivity.[4]

[1] "Comparisons of productivity performance across countries are central to many of the questions concerning long-run economic growth" (Bernard and Jones, 1996, p.1216).

[2] For example, Griliches and Mairesse (1983) compared the average productivity of firms in France and the United States.

[3] Fukao, Inui, Kabe, and Liu (2008) compared the productivity of listed firms in China, Japan, and South Korea. Fukao, Inui, Ito, Kim, and Yuan (2011) extended the analysis, adding Taiwanese listed firms. Jung, Lee, and Fukao (2008) and Jung and Lee (2010) compared the productivity of listed firms in Japan and Korea. All of these studies focus on the difference in the average productivity gap.

[4] Most notably, Aw, Chung, and Roberts (2000) compared large scale Korean and Taiwanese plant-level data, but the period is different between two data sets. Ahn, Fukao, and Kwon (2004) utilised Korean plant-

Finally, some of the previous studies rely on private data sources that are rich but limited in scope. For instance, from the MacKynsey Global Institute firm-level database, Baily and Solow (2001) were able to compute several industry productivity gaps across the United States, Germany, Japan and France, but only for a limited number of industries.[5]

The other strand of literature is the study of firm heterogeneity in international trade. With the growing number of studies on the relationship between firm productivity and exports in various countries, we now know that, on average, exporters outperform non-exporters in terms of TFP.[6] However, the previous studies on firm heterogeneity and exports lack the perspective offered by an international comparison. An exception is a study by the International Study Group on Exports and Productivity (ISGEP) (2008), which analysed the export premia for 14 countries.[7] This study compared the export premia across countries but not the firm productivity level. Therefore, none of the previous studies directly compared the productivity of exporters (or non-exporters) between two different countries.

Both strands of research have made significant contributions to the literature. However, the link between the two strands, namely the connection between firm export heterogeneity and international productivity gaps, has not been explored. In this paper, we propose to fill this gap by investigating how international productivity gaps relate to firms export status, using balance sheet information and the export status of the universe of French and Japanese firms operating with 50 or more employees in 18 narrowly defined manufacturing industries.

We proceed in two steps. In the first step, we implement a simple empirical strategy to reconcile the need for international comparisons of firm-level productivity with the requirement of confidentiality in firm-level data. We extend the productivity index method of Good, Nadiri, and Sickles (1997) and adapt both parametric t-tests and non-parametric Kolmogorov-Smirnoff (KS) tests of stochastic dominance to allow for cross-country comparisons without merging the two country data sets into a unique set.[8] In the second step, we provide a simple framework to relate our empirical findings to recent models of international trade with heterogeneous firms. Specifically, we show that our results are consistent with new models of international trade that feature firm heterogeneity, country-specific productivity advantages, and country-specific trade costs.

This paper utilises firm-level data sets in France and Japan because these data have the following advantages. First, the French and Japanese firm-level data are highly comparable to one another, which is a necessary prerequisite for estimating productivity level differ-

level data and Japanese firm-level data. Strictly speaking, therefore, some of the previous studies did not directly compare the productivity of *firms* (or plants) from two different countries in the same industry-year.

[5]For France and Japan specifically, this previous study provides an estimate of the average productivity gap for the *Automobile* industry only. Japanese firms were shown to be, on average, twice as productive as their French counterparts in this specific industry (See Baily and Solow, 2001, p.156, Table 2).

[6]Greenaway and Kneller (2007), Wagner (2007, 2012), and Hayakawa, Machikita, and Kimura (2012) provided excellent literature reviews on firm heterogeneity and export behaviours.

[7]The ISGEP study includes France, but not Japan.

[8]Following Delgado, Fariñas, and Ruano (2002) and Fariñas and Ruano (2005), our empirical analysis relies on the concept of first-order stochastic dominance. Establishing stochastic dominance means that one cumulative distribution lies to the right of another. Therefore, these tests go beyond the tests for differences in average productivity that are typically found in the international productivity gap literature.

ences. Second, France and Japan are expected to exhibit substantial productivity gaps, at least in some narrowly defined industries. Consequently, together they constitute a good case study to investigate whether all firms in an industry exhibit the same productivity advantage or disadvantage over their foreign counterparts, or alternatively, whether international productivity gaps are sensitive to firm characteristics. Third, France and Japan can also be expected to exhibit substantial relative trade costs differences. French firms benefit from the proximity of a large E.U. market to which they can export with admittedly low export costs. Japanese firms instead must incur significant export costs due to their geographic location and the absence of a common market or currency. This last feature is likely to be a key to understanding the specific relationship between international productivity gaps and the firm export status.

This paper is structured as follows. Section 2 presents our empirical strategy for providing international productivity comparisons built from firm-level data. Section 3 explains about the data and some important comparability issues. Section 4 presents our estimates of the average productivity gaps between France and Japan and shows their consistency with the previous estimates based on industry-level data. The comparison of the complete distributions of different subsets of French and Japanese firms is performed in Section 5, which establishes the relationship between international productivity gaps and the export status of firms. Section 6 connects our empirical findings to the recent theory of international trade with heterogeneous firms. A summary of our findings and implications is presented in the final section.

2 Empirical Methodology

We begin by describing how one can compute internationally comparable TFP indices at the firm level. The difficulty is that, due to data confidentiality restrictions, one cannot simply merge the two datasets into one unique dataset. One must therefore develop alternative methods through which significant differences between any two countries can be inferred.

2.1 Multilateral firm-level TFP indices for international comparisons

International comparisons of productivity have always been challenging because of the difficulty of comparing data that are drawn from different national sources. Above and beyond the problems of currency conversion, of consistent industry classifications, and of data comparability, performing firm-level comparisons adds one additional challenge: the confidentiality of individual data. As a rule, national statistical offices do not allow micro-level data to be merged with foreign datasets.[9] In the case of France and Japan, both INSEE for France and

[9]Non-confidential micro-level databases exist from private sources. See the Amadeus database, which provides firm-level data for a very large number of firms located in 41 different European countries, for instance. However, those data sets are usually less comprehensive than the firm-level statistics collected by the national offices.

METI for Japan impose these restrictions on the use of their comprehensive micro-level data sets.

The issue of confidentiality raises the challenge of estimating comparable TFP measures without pooling together firm-level data from different countries. For that purpose, this paper proposes to implement a non-parametric methodology based on the multilateral index number approach developed by Good, Nadiri, and Sickles (1997) (hereafter, GNS).[10]

The productivity index method allows for separate (but comparable) measures of individual TFP across countries without requiring that the firms share the same production technology.[11] Another advantage of the productivity index method is that it is similar to the methodology implemented by the Groningen Growth Development Centre (GGDC). The GGDC has recently provided estimates of international TFP gaps at the mostly detailed industry-level based on the recently compiled EU-KLEMS database (See O'Mahony and Timmer, 2009 for a description of the dataset). Implementing a similar methodology to the GGDC will allow us to accurately check the consistency between the estimates of productivity gaps built from firm-level data and the estimates of productivity gaps built from industry-level data.

The original GNS index is based on the existence of a hypothetical reference firm for each industry that has the arithmetic mean values of log output, log input, and input cost shares for the firms belonging to that industry in each year. Each firm's output and inputs are measured relative to this reference firm. The reference firms are then chain-linked over time. Hence, the index measures the TFP of each firm in year t relative to that of the reference firm in the initial year ($t = 0$).

Let θ_{it}^k and θ_{rt}^k be (the log of) total factor productivity for firm i and the reference firm r, respectively, operating in year t in industry k. The GNS index defines the TFP index for firm i operating in industry k in year t as follows:

$$\begin{aligned}\theta_{it}^k - \theta_{r0}^k \simeq & \left(\ln Y_{it}^k - \overline{\ln Y}_{rt}^k\right) + \sum_{\tau=1}^{t}\left(\overline{\ln Y}_{r\tau}^k - \overline{\ln Y}_{r\tau-1}^k\right) \\ & - \sum_{j\in\{K,L,M\}} \frac{1}{2}\left(s_{ijt}^k + \bar{s}_{rjt}^k\right)\left(\ln j_{it}^k - \overline{\ln j}_{rt}^k\right) \\ & + \sum_{\tau=1}^{t}\sum_{j\in\{K,L,M\}} \frac{1}{2}\left(\bar{s}_{rj\tau}^k + \bar{s}_{rj\tau-1}^k\right)\left(\overline{\ln j}_{r\tau}^k - \overline{\ln j}_{r\tau-1}^k\right), \qquad (1)\end{aligned}$$

[10] A number of studies on firm export heterogeneity employ the multilateral index number approach. See Aw, Chen, and Roberts (2001), Aw, Chung, and Roberts (2003), Girma, Kneller, and Pisu (2005), and Kimura and Kiyota (2006), for example.

[11] On the flip side, this non-parametric method is sensitive to measurement errors (For more detail on the relative advantage of non-parametric and semi-parametric methodologies, see van Biesebroeck, 2007). As we will discuss below, both the French and the Japanese data are from government statistics; these surveys are compulsory for firms. Therefore, the data are less likely to be subject to measurement errors than the data coming from private sources. In that respect, the use of the index method may be more appropriate in our research than in the researches that rely on private firm-level data sources.

where $\ln Y_{it}^k$, $\ln j_{it}^k$, and s_{ijt}^k are the log output, the log input of factor j, and the cost share of factor j, respectively for firm i in industry k. $\overline{\ln Y}_{rt}^k$, $\overline{\ln j}_{rt}^k$ and $\bar{s}_{rjt}^k$ are the same variables for the reference firm r and are equal to the arithmetic mean of the corresponding variable over all firms operating in industry k in year t.

The first term of the first line indicates the deviation of firm i's output from the output of the reference firm in year t. The second term represents the cumulative change in the output of the reference firm from year 0 to year t. The same operations are applied to each input j in the second and the third lines, weighted by the average of the cost shares.

We extend the GNS index to international firm-level comparisons using a common reference firm to compute the relative TFP indices for firms belonging to different countries. To start with, suppose that all of the relevant firm-level variables are expressed in common units irrespective of the country (we will address the issue of the comparability of the data later on in the next section). Let us focus on one industry and two countries: France (FR) and Japan (JP). Define France as the country of reference. Discarding the industry subscript k for simplicity of notation, the individual relative TFP indices for Japan can be computed using the following equation adapted from equation (1):

$$\begin{aligned}
\theta_{it}^{JP} - \theta_{r0}^{FR} \simeq\; & \left(\ln Y_{it}^{JP} - \overline{\ln Y}_{rt}^{FR}\right) + \sum_{\tau=1}^{t} \left(\overline{\ln Y}_{r\tau}^{FR} - \overline{\ln Y}_{r\tau-1}^{FR}\right) \\
& - \sum_{j\in\{K,L,M\}} \frac{1}{2}\left(s_{ijt}^{JP} + \bar{s}_{rjt}^{FR}\right)\left(\ln j_{it}^{JP} - \overline{\ln j}_{rt}^{FR}\right) \\
& + \sum_{\tau=1}^{t} \sum_{j\in\{K,L,M\}} \frac{1}{2}\left(\bar{s}_{rj\tau}^{FR} + \bar{s}_{rj\tau-1}^{FR}\right)\left(\overline{\ln j}_{r\tau}^{FR} - \overline{\ln j}_{r\tau-1}^{FR}\right), \qquad (2)
\end{aligned}$$

where $\ln Y_{it}^{JP}$, $\ln j_{it}^{JP}$, and s_{ijt}^{JP} are defined as previously but are now specific to Japan. $\overline{\ln Y}_{rt}^{FR}$, $\overline{\ln j}_{rt}^{FR}$, and $\bar{s}_{rjt}^{FR}$ are the same variables for the French reference firm operating in year t and equal to the arithmetic mean of the corresponding variable over all French firms operating in year t. Note that we do not need to merge firm-level data sets between two countries; we need to exchange the information on the French and Japanese reference firms. We can then establish a firm-level comparison between two countries while adhering to the confidentiality restriction.

2.2 Testing procedure under confidentiality restrictions

Once we have estimated the individual relative productivity indices using equation (2), we can investigate the industry productivity gaps between France and Japan by two means. First, we can use the standard student t-test of equality of the TFP means between the French and Japanese firms operating in the same industry. Second, we can use the testing procedure proposed by Delgado, Fariñas, and Ruano (2002) and Fariñas and Ruano (2005), which relies on the concept of first-order stochastic dominance. However, we must adapt this procedure to conform to the confidentiality restrictions imposed by both the French and the Japanese statistics offices.

First, addressing the t-test, the procedure is straightforward. Both countries must share the necessary scalar statistics to compute the t-statistic. When σ_θ^{FR} and σ_θ^{JP} are unknown and $\sigma_\theta^{FR} \neq \sigma_\theta^{JP}$, the t-statistic is as follows:

$$t_{df=(n_{JP}+n_{FR})} = \frac{\overline{\theta^{JP}} - \overline{\theta^{FR}}}{\sqrt{s_{JP}^2/n_{JP} + s_{FR}^2/n_{FR}}} \tag{3}$$

where df is the degree of freedom, $\bar{\theta}$ is the sample mean of the unknown population mean $\mu_{\ln TFP}$, s is the sample value of the unknown population standard deviations $\sigma_{\ln TFP}$ and n_c ($c \in \{FR, JP\}$) is the sample size for both Japan and France. The above implies that sharing the necessary sample statistics will allow us to compute the t-test, where the null hypothesis H_0 assumes the equality of means and the alternative hypothesis H_1 assumes that the two populations have significantly different means.[12]

Second, the first-order stochastic dominance tests that the productivity distribution of one type of firm lies to the right of another. If found to hold, the averages of the two distributions differ. Note that the difference in averages does not imply that the distribution whose average is larger stochastically dominates the other. Because the test compares the entire distribution, it enables us to examine whether the majority of firms of one type outperform the majority of the other type.

Let G^{FR} and G^{JP} denote the cumulative distribution functions of the productivity level corresponding to the French and Japanese firms for a given industry. The first-order stochastic dominance of G^{JP} with respect to G^{FR} is defined as $G^{JP}(\theta) - G^{FR}(\theta) \leq 0$ uniformly in $\theta \in \Re^+$, with strict inequality for some θ. The two-sided Kolmogorov–Smirnov (KS) statistic tests the hypothesis that both distributions are identical and the null and alternative hypotheses can be expressed as follows:

$$\begin{aligned} H_0: &\quad G^{JP}(\theta) - G^{FR}(\theta) = 0 \quad \forall\, \theta \in \Re^+ \\ H_1: &\quad G^{JP}(\theta) - G^{FR}(\theta) \neq 0 \quad \text{for some } \theta \in \Re^+. \end{aligned} \tag{4}$$

In contrast, the one-sided KS-test of the dominance of $G^{JP}(\theta)$ with respect to $G^{FR}(\theta)$ can be formulated as follows:

[12] One may argue that we conduct different non-parametric tests such as the Wilcoxon rank-sum test and the Mann and Whitney test to check the equality. Note, however, that it is impossible to merge firm-level data sets between France and Japan. Therefore, this paper employs a t-test. One drawback of the t-test is that it relies on the assumption that the firm-level TFP is normally distributed; this drawback is an issue because, as has been emphasised in the literature, firm-level TFP is usually *not* normally distributed in reality. Indeed, the null hypothesis that the distribution of firm-level TFP is normal is rejected in 17 out of 18 industries both in France and in Japan.

$$
\begin{aligned}
H_0: &\quad G^{JP}(\theta) - G^{FR}(\theta) = 0 \quad \forall\, \theta \in \Re^+ \\
H_1: &\quad G^{JP}(\theta) - G^{FR}(\theta) < 0 \quad \text{for some } \theta \in \Re^+.
\end{aligned} \tag{5}
$$

Let θ_i denote the productivity of firm i. Let n_{FR} and n_{JP} be the number of French and Japanese firms in the empirical distributions of G^{JP} and G^{FR}, respectively. Let N denote the total number of French and Japanese firms ($N = n_{FR} + n_{JP}$). The KS statistic for the one-sided and two-sided tests is given by the following:

$$
KS_1 = \sqrt{\frac{n_{FR} \cdot n_{JP}}{N}} \max_{1 \le i \le N} |G^{JP}(\theta_i) - G^{FR}(\theta_i)| \tag{6}
$$

and

$$
KS_2 = \sqrt{\frac{n_{FR} \cdot n_{JP}}{N}} \max_{1 \le i \le N} \left\{ G^{JP}(\theta_i) - G^{FR}(\theta_i) \right\}, \tag{7}
$$

respectively. The acceptance of the null hypothesis in equation (6) implies that the distribution of G^{JP} dominates G^{FR}. To establish the stochastic dominance of the distribution of G^{JP} with respect to G^{FR} requires the rejection of the null hypothesis in the two-sided test in equation (7), but not the rejection of the null hypothesis in equation (6).

Note that in equations (6) and (7), the maximum distance between $G^{FR}(\theta_i)$ and $G^{JP}(\theta_i)$ and the number of firms n_{FR} and n_{JP} is required for both the French and Japanese sample. The computation of this maximum distance would necessitate that both samples be merged to compute it. However, to apply the KS-tests to allow international firm-level TFP comparisons is not possible because merging the firm-level TFP series is not an option, again because of the confidentiality restrictions. The confidentiality of the firm-level data sets imposes restrictions on the production of tables, data series, or summary statistics in such a way that the identification of individual firms is made impossible.

Among various rules, the principal restriction implies that any cell within a produced table must ensure the anonymity of the individual firms. To compute the maximum distance, our choice is to use $(n_{FR}/5)$-tiles and $(n_{JP}/5)$-tiles to approximate the cumulative density function $G(\theta)$ for France and Japan, respectively, while obtaining $(n_{FR} \cdot n_{FR})/N$ from the real number of firms.[13]

One additional concern is that the firms faced various industry-country-specific shocks such as the business cycle and the changes in the real exchange rate. Therefore, prior to the computation of t statistics and empirical densities, all observations have been transformed to account for the shocks common to all firms within an industry-country:

$$
\widetilde{\theta_{it}^{c,k}} = \theta_{it}^{c,k} - \overline{\theta_t^{c,k}} + \overline{\theta^{c,k}}, \tag{8}
$$

where c and k represent country c ($\in \{FR, JP\}$) and industry k, respectively. Hence, $\overline{\theta_t^{c,k}}$ is the average TFP performance in industry k for country c for a given year t, whereas $\overline{\theta^{c,k}}$ is

[13] In a different data set, we confirmed that the distance based on these fractiles produced a good estimate of the distance based on original data when the number of observation is large.

the average TFP performance in industry k for country c across all years. The latter can also be extended to compare all manufacturing firms within the economy as a whole by adding the overall sample mean $\overline{\theta^c}$, not the mean specific to the industry to which the firm belongs ($\overline{\theta^{c,k}}$). In Section 5 below, we present the results of the KS-tests performed on the empirical densities derived from the firm data set, both at the entire manufacturing level and at the 2-digit industry level. We also present the results of those tests performed separately on the subsets of the exporting and non-exporting firms.

3 Data

In the data step, we begin by presenting our data sources. Then, we address comparability issues, which are central to any international comparison of productivity based on firm-level data sets.

3.1 Data sources

Both the French and the Japanese firm-level data used in this study are collected by national statistical offices. Data for France are 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 French National Statistical Office (INSEE). This survey has been 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 as well as information on the international activities of the firms.

Data for Japan are drawn from the confidential micro 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, the Ministry of Trade, Economy and Industry (METI) (1994–2006). This survey was first conducted in 1991 and then annually from 1994. The main purpose of the survey is to capture statistically the overall picture of Japanese corporate firms in light of their activity diversification, globalisation and strategies for research and development and information technology.

The strength of both surveys is the sample coverage and the reliability of information. In France, the survey covers only manufacturing firms but it is compulsory for all firms with over 20 employees. In Japan, the survey is compulsory for firms with over 50 employees and with capital of more than 30 million yen industries (some non-manufacturing industries such as construction, medical services and transportation services are not included). One common limitation is that some of the information on financial and institutional features is not available, and small firms (with fewer than 50 workers for Japan and fewer than 20 workers for France) are excluded.[14]

[14] In 2002, the *BSJBSA* covered approximately one-third of Japan's total labour force, excluding the public, financial and other services industries that are not covered in the survey (Kiyota, Nakajima, and Nishimura, 2009). In the same year, the *EAE* covered approximately 75 per cent of aggregate manufacturing employment

From the *EAE* and the *BSJBSA* surveys, we constructed two separate unbalanced panel data sets with the same coverage, i.e., covering the period from 1994 to 2006 and including only firms with over 50 employees, to estimate equation (2). Equation (2) can be estimated without merging national firm-level data sets. Only the characteristics of the French representative firms (one for each industry) must be shared across countries.

3.2 Some discussions on the comparability of the data

One crucial requirement for our study is that the firm-level variables built separately in different countries be comparable. In that respect, the present study benefits from the fact that France and Japan conduct very similar types of firm-level surveys[15], so that we can 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.

Industry classification

Our first challenge is to build a common industry classification between the French and Japanese data sets. Actually, we confront two different issues here. First, the nomenclatures of the industry codes in the two firm-level surveys, namely the *BSJBSA* and the *EAE*, are not the same. Second, within each country, the nomenclatures of the industry codes in the industry level databases do not always concord with the nomenclatures of the industry codes in the firm-level databases. To overcome these difficulties, we built different concordance tables across different industry classifications, as is reported in Appendix A. Our final classification consists of 18 different manufacturing industries (see Table 7).

Definition of the primary firm-level variables

We then must establish firm-level nominal input and output series. Here, we make a number of simplifying assumptions. First, we assign multi-product firms and/or firms that shift industries to only one industry code, which is defined as the code in which the firm has the highest average sales over the period of observation. Second, in each country $c(\in \{FR, JP\})$, we define the firm output Y_{it}^c as the nominal sales divided by the industry gross output price deflator p_t^c. The inputs consist of labour, capital, and intermediate inputs. Labour L_{it}^c is obtained by multiplying the number of employees in the firm by the average hours worked by industry. The real capital stock K_{it}^c is computed from tangible assets and investments based on the perpetual inventory method. The intermediate inputs M_{it}^c are real intermediate inputs and are defined as nominal intermediate inputs deflated by the industry input price

and 85 per cent of aggregate manufacturing value added (Bellone, Musso, Nesta, and Quéré, 2008) excluding the *Food, Beverages, and Tobacco* industry, which is not covered in the survey.

[15]Because of the high comparability of the firm-level data in Japan and France, a recent international comparative study by Dobbelaere, Kiyota, and Mairesse (2012) also utilised the *EAE* and the *BSJBSA*.

deflator p^c_{Mt} (For more details on how the main variables have been computed, see Appendix A).

Purchasing power parity (PPP)

Finally, we must 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 thirty OECD countries.[16] In the GGDC database, both French and Japanese PPP series are expressed relative to the United States. On this basis, we derive the French-Japanese-industry-specific PPP series as follows.[17]

Our very first choice is simply that the burden of the PPP conversion should bear on only one country, France in our case, so that the other country (i.e., Japan) can compute its TFP indices in an independent fashion. The conversion goes as follows. Let X^{φ}_{it} be input K, L, and M or output Y of any firm i at time t, expressed in the local currency φ. Discarding the subscripts i and t for simplicity of notation, the conversion into US$ PPP reads as follows:

$$X^{\$} = \frac{X^{\varphi}}{PPP^X_{\varphi \to \$}} \tag{9}$$

Knowing that $PPP^X_{\$ \to \varphi} = [PPP^X_{\varphi \to \$}]^{-1}$, the conversion of $X^{€}$ into $X^{¥}$ implies that we express € in US$ PPP first and then express $X^{\$}$ in ¥ as in the following:

$$X^{¥,FR} = \frac{X^{€,FR}/PPP^X_{€ \to \$}}{PPP^X_{\$ \to ¥}} = X^{€,FR} \times \frac{PPP^X_{¥ \to \$}}{PPP^X_{€ \to \$}}, \tag{10}$$

where FR represents French firms. Variable $X^{¥,FR}$ is the nominal value of X in ¥, to which the national industry-specific deflator is then applied. Note that whether we compute the conversion before or after deflating the series makes no difference in the final result.

The GGDC PPP series provide information on the purchasing power parities for Y, K, and M, but they do not provide series on investments. Inklaar and Timmer (2008), however, provide us with guidance. Noting that $PPP^K_{\varphi \to \$}$, the purchasing power parity for capital K between currency φ and US dollars, we know that

$$PPP^K_{€ \to \$} = PPP^I_{€ \to \$} \times \frac{p^K_{FR}/p^I_{FR}}{p^K_{US}/p^I_{US}}, \tag{11}$$

where p^K_{FR} denotes the user cost of capital in France, and p^K_{US} denotes the user cost of capital in the United States (Inklaar and Timmer, 2008, p.35). Similarly, p^I_{FR} and p^I_{US} denotes the

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

[17] We also used industry classification concordance tables for this purpose. For more details, see Appendix A.

current investment price in France and in the United States, respectively. Noting that for our base year 1997, p^I_{FR} and p^I_{US} are set to unity, we express the investment PPP as a function of capital PPP as in the following:

$$PPP^I_{€\rightarrow\$} = PPP^K_{€\rightarrow\$} \times \frac{p^K_{US}}{p^K_{FR}} \tag{12}$$

Based on all of the above, the conversion of the investment series $I^{€}$ into $I^{¥}$ is

$$I^{¥,FR} = I^{€,FR} \times \frac{PPP^I_{¥\rightarrow\$}}{PPP^I_{€\rightarrow\$}} = I^{€,FR} \times \frac{PPP^K_{¥\rightarrow\$}}{PPP^K_{€\rightarrow\$}} \times \frac{p^K_{JP}}{p^K_{FR}}, \tag{13}$$

where p^K_{JP} represents the user cost of capital in Japan. Based on this new series of investments, we compute capital stock K using the permanent inventory method.

Using the industry-specific PPP series provided by the GGDC, based on the industry classification common to both Japan and France, Equation (2) can be computed for each data set separately. This calculation produces comparable relative TFP indices for each individual firm belonging to the same industry in France and in Japan.

4 Average Industry Productivity Gaps Built from Firm-Level Data

In this section, we present our computations for the international productivity gaps and then test their consistency with the existing evidence built from the industry-level database.

Table 1 presents the mean and standard deviation of the TFP distributions in Japan and France separately for each of our 18 industries in France and Japan. The table also presents the mean TFP of Japanese firms relative to their French counterparts as an estimate of the TFP gap between the two populations of firms. A value above unity means that Japanese firms have, on average, a productivity advantage over their French counterparts, while a value below unity means that Japanese firms have, on average, a productivity disadvantage compared to their French counterparts. The values are reported for our most recent available data, namely 2006.

Table 1 shows that cross-industry differences are large in our disaggregated industrial classification. Specifically, the TFP levels of Japan relative to France range from 33 per cent in the *Rubber and plastic* industry to 212 per cent in the *Textile* industry. The Japanese firms are found to outperform their French counterparts mostly in equipment industries such as the *Motor vehicles* and *Other transportation equipment* industries or the *Electric machinery and apparatus* industry. However, the French firms outperform their Japanese counterparts in most of the final or intermediary goods industries such as *Manufacture of wood*, *Chemical products*, *Rubber and plastic*, *Non metallic mineral products* , and *Furniture*. Altogether, it appears that the Japanese manufacturing firms outperform the French ones in 10 of the 18 manufacturing industries investigated.

[Table 1 about here.]

One important issue is whether these gaps, based on firm-level data, are consistent with the previous gaps found using industry-level data. One concern here is that our estimates could be biased towards larger firms, screening out the role played by companies of less than +50 employees.[18] To check the consistency between our estimates and the estimates built using the EU-KLEMS database, we use the concordance table provided in Appendix A (See Table A3).

The most detailed productivity gap estimates that exist at the industry level are the ones recently compiled by GGDC from the EU-KLEMS data. According to the GGDC Productivity Levels Database, Inklaar and Timmer (2008) provide the TFP based on a gross output comparison for a set of detailed industries for 20 OECD countries including France and Japan for the benchmark 1997 year. Compared to the estimates based on the EU-KLEMS database, one advantage of our estimates is that they provide more details for the industrial classification because firms are categorised in 18 different manufacturing industries instead of 11 for the corresponding EU-KLEMS industry coverage.

Nonetheless, we propose aggregating our data to check the consistency of the two estimates, i.e., those built from firm-level data and those built from industry-level data. The results of this exercise are reported in Table 2. These results compare the relative TFP levels of Japan and France for 11 industries; these industries were selected because we were able to provide figures for the benchmark year 1997 that were comparable with the GGDC figures.[19]

[Table 2 about here.]

Table 2 shows a strong consistency between the GGDC measures based on industry-level data and our own measures based on firm-level data. In 8 of 11 industries, the relative rankings of France and Japan are consistent from one series to the other. Among them, Japan has the productivity lead in three industries (*Textiles, textile products, leather, and footwear*, *Transport equipment*, and *Electrical and optical equipment*) while France has the productivity lead in five industries (*Wood and products of wood and cork, Chemicals and chemical products, Other non-metallic mineral products, and Manufacturing nec; recycling*). In the remaining three industries for which the ranking is not consistent, Table 3 reveals minor rather than radical differences. In the *Basic metals and fabricated metal products* and the *Machinery, nec* industries, Japan is slightly more productive than France (less than five per cent more productive) according to the GGDC series, while Japan is slightly less productive than France (less than five per cent less productive) according to our own series.

[18] Another concern here could be that our firm-level TFP estimates do not control for the quality of inputs. In contrast, the estimates provided by the GGDC productivity database are based on two different types of labour (high skilled and others) and two different types of physical capital (ICT capital and non-ICT capital).

[19] We had to exclude the *Food products, beverages, and tobacco* industry and the *Coke, refined petroleum products, and nuclear fuel* industries, for which we lacked firm-level data in the *EAE* and/or the *BSJBSA*) surveys. We also excluded the *Post and Communications* industry, which is not part of manufacturing and for which we do not have corresponding firm-level data in the *EAE* survey.

The strongest difference exists for the *Pulp and paper, printing and publishing* industry, for which Japan is almost as productive as France according to the GGDC series and 16 per cent more productive than France according to our own series.

A final, interesting feature of Table 2 is that the dispersion of the TFP measures based on firm-level data is larger than the dispersion of the TFP measures based on industry-level data. For each of the industries where a clear productivity lead exists for Japan or France, the productivity advantage of the leader is always higher in our computations than in the computations based on industry-level data.

All in all, the strong concordance between industry-data based TFP series and firm-data based TFP series provide us with some confidence in the robustness of our firm-level relative TFP indices. We are now ready to discuss the results that we obtain from the estimates of the international productivity gap across different subsets of manufacturing firms within industries.[20]

5 International Comparisons of Firm Distributions by Export Status

In this section, we investigate the extent to which international productivity gaps are sensitive to the export status of firms. We begin by showing some descriptive statistics about the different subsets of exporting and non-exporting firms in France and in Japan. We then move to cross-country comparisons of the productivity distributions between these different subsets of firms by industry.

5.1 Exporters and non-exporters in France *versus* Japan

Let us first show some basic comparative statistics about the commitment of French and Japanese firms to exporting activities. The exporter participation rate (defined as the percentage of exporting firms) and the export intensity (defined as the average share of exports in total sales for exporting firms) are reported, first for the entire manufacturing group and then for each of our 18 industries separately, as an average over the period of investigation 1994–2006, in Table 3.

[Table 3 about here.]

[20] In further investigations reported in Appendix B, we examined whether our TFP gap estimates were consistent with the standard indexes of comparative advantage as well. This investigation showed that our TFP gap estimates were broadly consistent with the comparative advantage estimates in the sense that Japan was usually shown to exhibit a comparative advantage over France in industries in which Japanese firms were, on average, outperforming their French counterparts. However, some striking exceptions appeared, such as the *Textile* and *Clothing* industries, in which Japan was shown to exhibit a strong productivity advantage without exhibiting any comparative advantage. This discrepancy between the relative productivity and export performance of Japanese firms in some specific industries can be regarded as new evidence supporting the idea that other dimensions of industry and/or firm heterogeneity, such as product quality differentiation, matter.

Table 3 documents that both the exporter participation rate and the export intensity are much higher in France in comparison to Japan. These patterns hold both at the whole manufacturing level and at the level of each of our 18 detailed industries. According to the information reported for the whole manufacturing level, the average share of firms with at least 50 employees that export in France is approximately 85 per cent, while it is only approximately 28 per cent in Japan. The discrepancy in the export intensity is smaller, but the average export intensity is still over two times larger in France than in Japan. Altogether, these figures suggest that being a part of a large integrated market, as France is in Europe, makes a significant difference in terms of both the extensive and the intensive margins of international trade.[21]

Our next experiment consists of computing the so-called exporter productivity premia, defined as the ceteris paribus percentage difference of productivity between exporters and non-exporters. Essentially, for each separate country, we regress the log of the firm TFP on the current export status dummy and on a set of industry-year dummy variables. We perform this exercise first for the entire set of manufacturing firms and then for different firm size classes distinguishing *Small and Medium Enterprises* (SMEs) as firms of 50 to 249 employees, *Intermediate Firms* as firms of 250 to 500 employees, and *Large firms* as firms of over 500 employees . The results are reported in Table 4 below.

[Table 4 about here.]

Table 4 shows the existence of an export premium both in France and in Japan. Moreover, the premium is higher in Japan than in France. It is approximately five per cent in Japan while it is only 1.4 per cent in France when estimated for the entire set of manufacturing firms. The breakdown of the sample by size class shows that in France, an export premium exists only within the group of small- and medium-sized enterprises (SMEs). On the reverse, within the groups of intermediate and large French firms, being an exporter does not discriminate the most productive firms. This finding is consistent with the fact that most French firms export to the large and integrated European market without significant trade costs. Consequently, being an exporter in France is not discriminating in terms of productivity performance.[22] Only French SMEs may face specific trade barriers even within Europe, which show up in a low but still positive and significant export premium of approximately 1 per cent. In contrast, an export premium exists within each group of small and medium, intermediate and large firms in Japan. As expected, the export premium is higher within the group of SMEs than it is within the group of large firms. However, the export premium for large firms in Japan is still 2.6 per cent. In the next subsections, we further investigate this working hypothesis.

[21] To investigate further the differences between France and Japan in terms of firm export behaviours, we refine these statistics for different firm size classes. For more details, see Appendix C.

[22] In another paper, working with data from the French Innovation Survey 2005, Bellone, Guillou, and Nesta (2009) show that, on average, French firms that export only within Europe do not perform better than their non-exporting counterparts. Only French firms that export outside of Europe display a productivity premium of approximately 7 per cent over their competitors. These results are consistent with the idea that export costs are low, on average, for French firms exporting only within Europe.

5.2 The relative performance of French and Japanese exporters

Let us begin with graphical descriptions of the comparable cumulative distributions of French and Japanese firms at the whole manufacturing level. We first graph those distributions for the full sample of manufacturing firms and then separately for the sub-samples of exporting and non-exporting firms. Specifically, Figure 1 displays the size (measured as the number of employees) and TFP distributions for all manufacturing firms in France and in Japan.[23] Figure 2 replicates the same exercise but only for TFP distributions, and it discriminates between exporters and non-exporters.

[Figure 1 about here.]

[Figure 2 about here.]

Figure 1 shows that the size distribution of Japanese manufacturing firms dominates the distribution of their French counterparts. This feature is consistent with previous findings in the Industrial Organisation literature, which emphasises, for instance, the specific ownership structures of Japanese firms (e.g., Lee and O'Neill, 2003). Moreover, Figure 1 also shows that Japanese manufacturing firms (slightly) outperform their French counterparts in terms of TFP.[24] However, Figure 2 reveals that at the entire manufacturing level, the productivity gap of exporters is larger than the productivity gap of non-exporters. Moreover, this productivity gap is also larger than the average productivity gap.

We next investigate whether this pattern still holds at the industry level. We also want to quantitatively compare the average productivity gaps across the different subsets of firms. For that purpose, we perform t-tests discriminating exporters from non-exporters in each of the 18 industries. The tests are performed over the entire 1994–2006 period. The results are reported in Table 5.

[Table 5 about here.]

The t-tests confirm the idea that the productivity gaps are larger across exporters than across non-exporters at the whole manufacturing level. Basically, Japanese manufacturing exporters outperform their French counterparts with an average TFP advantage of five per cent while the average TFP advantage of Japanese firms computed for all manufacturing firms

[23] Further detailed graphical descriptions of cumulative French and Japanese size and TFP distributions by industry are presented in Appendix D.

[24] Note that there is an apparent paradox between this finding and the findings reported in Inklaar and Timmer (2008), according to which France outperformed Japan by 14 per cent in the *Mexelec* aggregate. This result points to two main differences between the industry coverage from the FJ classification and the one from EU-KLEMS. First, contrary to the coverage of *Mexelec* in the EU-KLEMS classification, our coverage of manufacturing includes the *Electric machinery and apparatus* industry, in which Japanese firms perform better than French firms according to both the GGDC estimates and our own. Second, because of data constraints, our FJ classification excludes two industries in which Japan performs particularly poorly according to the GGDC estimates: the *Food products, beverages, and tobacco* and the *Coke, refined petroleum products, and nuclear fuel* industries.

is only two per cent. However, Japanese non-exporters outperform their French counterparts by only 1 per cent.

Looking at individual industries establishes a similar pattern: the productivity gap between Japanese and French exporters is generally larger than the average productivity gap in the same industry. For instance, the productivity advantage of Japanese exporters over their French counterparts in the *Textile* industry is 78 per cent (row 5 of Table 5), while the average productivity advantage of Japan over France in that industry is 72 per cent (row 4 of Table 5). Conversely, in industries where France has the productivity lead (8 out of 18 industries), the productivity gap between Japanese and French exporters is generally smaller than the average productivity gap. For instance, the productivity disadvantage of Japanese exporters compared to their French counterparts in the *Manufacture of wood* industry is 38 per cent (row 11 of Table 5), while the average productivity disadvantage of Japan compared to France in that industry is 41 per cent (row 10 of Table 5).

Because our t-tests rely on the simplifying but unverified assumption that the firms' TFP are normally distributed within country-industry, we propose to further perform non-parametric KS tests of stochastic dominance following the adapted methodology explained in Section 2 above. Recall that the KS-test is performed on the kernel densities derived from the firm data set, both at the entire manufacturing group level and at the 2-digit industry level. Recall also that, at this stage of our testing procedure, all observations have been transformed to account for the shocks common to all firms within an industry-country. The results of the KS-test are reported in Table 6. Note that the negative distance implies first order stochastic dominance of the productivity distribution of Japanese firms with respect to that of French firms, so that the distribution of Japanese firms lies to the right of the distribution of French firms. Table 6 indicates that the results are systematically consistent with the t-tests.

[Table 6 about here.]

To summarise, the striking evidence is that the productivity gap among Japanese and French exporters is larger in the industries in which the Japanese firms have a productivity advantage and smaller in the industries in which the French firms have a productivity lead. This empirical pattern indicates that the average productivity gap across exporters of different countries is driven by something other than mere comparative advantage. In the section below, we propose an explanatory framework that is consistent with a large class of new models of international trade with heterogeneous firms to show how selection effects establish a link between international productivity gaps and the export status of firms in the case where countries differ both in terms of average productivity and in terms of trade costs.

6 Linking Our Empirical Evidence to Theory

How can one explain the systematic difference between the international productivity gaps of exporters and the average international productivity gaps? On the one hand, if country-specific productivity advantages were the only force driving international productivity gaps, we should not observe any differences between the average industry gaps and the gaps of exporters or non-exporters considered separately. On the other hand, if the learning by exporting mechanism was the primary force driving the productivity gaps between exporters and non-exporters, we should observe that the productivity gap across the exporters of two different countries is systematically narrower than the productivity gaps across the non-exporters of the two same countries. Specifically in the frame of our Japan-France comparison, we should observe that this pattern holds in all industries, and not only in industries in which Japan has a productivity disadvantage.

The learning by exporting mechanisms could be asymmetric across countries. In view of our findings, Japanese firms could then be more inclined to learn-by-exporting than their French competitors. This conjecture is consistent with the idea that the two countries differ extensively in their geographic location, in the institutional environment and in the regulatory framework for the export markets. French firms are obviously located at the heart of the large EU market with a common currency, whereas Japanese firms must ship any unit of export overseas. Consequently, French and Japanese firms may face very different trade-offs when deciding whether or not to expand their activities abroad.

In this section, we formally explore how country-specific export costs impact the international productivity gaps. Assume that firm productivity is distributed normally in two countries.[25] These two small open economies trade with the rest of the world and are indexed as Country 1 and Country 2, respectively. Each country is then characterised by a firm distribution $G(z)$, which encompasses a country-specific component, so that Country 1 benefits from a productivity advantage over Country 2. Assume further that export costs in Country 1 are higher than in Country 2: $c_{X,1} > c_{X,2}$, where $c_{X,1}$ and $c_{X,2}$ are export costs incurred by firms from Country 1 and Country 2, respectively.[26]

The productivity gap between Country 1 and Country 2 can be expressed as $P = E(\theta_1) - E(\theta_2)$, where $E(\theta)$ is the expected level of productivity for a given firm. If firm productivity is distributed normally in both countries, one can write $P = \mu_1 - \mu_2$, where μ_c represents the first moment of the normal distribution for country c. To incur export costs $c_{X,1}$ and $c_{X,2}$, firm efficiencies must exceed the threshold productivity levels $\theta_{c_{X,1}}$ and $\theta_{c_{X,2}}$, respectively. Under perfect sorting, all of the firms exceeding the country-specific threshold values $\theta_{c_{X,c}}$ manage to export, whereas those below focus on the domestic market. This result implies that the mean of the exporters in a given country reads as follows:

$$E(\theta|\theta_i > \theta_{c_X}) = \mu + \sigma \frac{\phi(z)}{1 - \Phi(z)}, \tag{14}$$

[25] Whereas this assumption does not hold in practice, our results suggest that firm TFP distributions do not depart much from normality, as the t-tests produce results that are consistent with those obtained from the KS-tests. Consequently, we take advantage of the simplifying normality assumption to derive a formal relationship between the differentiated export threshold values and the relative productivity gaps.

[26] Export costs include both fixed and variable export costs. Export costs could reflect the differences in factor prices between two countries and domestic border effect. For the study about the domestic border effect, see Caughlin and Novy (2012).

where $\phi(.)$ and $\Phi(.)$ are the probability density function and the cumulative distribution function, respectively, of the standard normal, and $z = (\theta_{c_X} - \mu)/\sigma$. The usual z statistics must be interpreted, in this case, as the threshold productivity level relative to the productivity distribution of the country. In turn, $(1 - \Phi(z))$ provides us with the export participation rate. Hence, if $z_1 > z_2$, then $(1 - \Phi(z_1)) < (1 - \Phi(z_2))$: the relative export threshold of Country 1 exceeds that of Country 2, then the participation rate of Country 1 is lower than that of Country 2. Given this framework, the productivity gap between exporters from the two countries, P_X, reads as follows:

$$\begin{aligned} P_X &= E(\theta_1|\theta_{1,i} > \theta_{c_{X,1}}) - E(\theta_2|\theta_{2,i} > \theta_{c_{X,2}}) \\ &= \underbrace{(\mu_1 - \mu_2)}_{=P} + \sigma_1 \times \left(\tfrac{\phi(z_1)}{1-\Phi(z_1)} - \gamma \tfrac{\phi(z_2)}{1-\Phi(z_2)} \right), \end{aligned} \tag{15}$$

where $\gamma = \sigma_2/\sigma_1$ represents the standard deviation of the productivity distribution of country 2 relative to country 1. Equation (15) says that the productivity gaps between exporters from two countries are equal to the overall productivity gap $(\mu_1 - \mu_2)$, augmented with $(\phi(z_1)/(1 - \Phi(z_1)) - \gamma(\phi(z_2)/(1 - \Phi(z_2))$. The productivity gap between exporters from two countries will be larger (smaller) if $(\frac{\phi(z_1)}{1-\Phi(z_1)} - \gamma\frac{\phi(z_2)}{1-\Phi(z_2)}) > 0$, (resp., < 0). Assuming $\gamma = 1$, one can show that $\frac{\phi(z)}{1-\Phi(z)}$ is a monotonic transformation of z, so that the following holds:

$$\frac{\phi(z_1)}{1 - \Phi(z_1)} > \frac{\phi(z_2)}{1 - \Phi(z_2)} > 0 \text{ if } z_1 > z_2. \tag{16}$$

The above implies that the productivity gap between exporters P_X will be larger (smaller) than the overall productivity gap P if the relative threshold value z_1 is greater (smaller) than z_2: $P_X > P$ if $z_1 > z_2$.[27] In turn, the relative threshold value z_1 determines the participation rate of firms in international trade. Hence, under perfect sorting, the productivity gap between exporters between Country 1 and Country 2 will exceed the overall productivity gap when the participation rate of Country 1 is lower than the participation rate of Country 2.

[Figure 3 about here.]

Figure 3 illustrates this point. The figure displays the firm-level productivity distribution of two hypothetical countries, 1 and 2, with identical standard deviations, but with the mean value of the productivity of country 1, $E(\theta_1)$, lying to the right of the mean value of the productivity of country 2, $E(\theta_2)$. Assume further that the relative export threshold value z_1 is higher than the relative export threshold value z_2. This assumption implies that the export participation rate of country 1 is lower than the export threshold value of country 2. This relationship is illustrated by the shaded areas of the two productivity distributions, which, under perfect sorting, display firms that export to foreign markets. Figure 3 also shows the productivity mean of the exporters only. One easily observes that the productivity gap P_X is

[27] The condition holds as long as the relative standard deviation γ exceeds $\frac{\phi(z_1)}{1-\Phi(z_1)} / \frac{\phi(z_2)}{1-\Phi(z_2)}$.

larger than the overall productivity gap P, as a consequence of the relative export threshold value z, which is higher in country 1 that in country 2.

Note that the reverse mechanisms can easily be inverted to show that $\frac{\phi(z_1)}{1-\Phi(z_1)} < \frac{\phi(z_2)}{1-\Phi(z_2)}$ if $z_1 < z_2$, which in turn implies that $P_X < P$. This phenomenon occurs for France when we observe than the overall productivity advantage of French firms shrinks when focusing on exporting firms exclusively.

The above mechanism is consistent with a large class of models of international trade with heterogeneous firms. The mechanism states that in the presence of firm heterogeneity and differentiated trade costs across countries, the firm-selection effect partly determines international productivity gaps. This mechanism could thus fit both Melitz (2003)-type models or Bernard, Eaton, Jensen, and Kortum (2003)-type models. The mechanism is particularly consistent with the models that explicitly feature country-specific trade costs such as Helpman, Melitz, and Rubinstein (2008) or the models that feature firm heterogeneity, comparative advantage and country-specific trade costs all together such as the Bernard, Redding, and Schott (2007) model.

7 Concluding Remarks

This paper has measured international productivity gaps between French and Japanese manufacturing firms considering those firms as a group, by industry, and by export status. Using firm-level data for France and Japan from 1994 to 2006, one of the contributions of this paper has been to directly compare the distribution of firm-level total factor productivity (TFP) within the same industry across two different countries. Another contribution of this paper has been to propose an empirical protocol that reconciles the need to establish international comparisons of firm-level analysis with data confidentiality restrictions.

We found that Japanese firms outperform French ones in 10 industries out of 18. Regardless of the export status, French firms have the productivity lead in such industries as *Chemical products* and *Rubber and plastic*, whereas Japanese firms have the productivity lead in such industries as *Electric machinery and apparatus* and *Motor vehicles*. Moreover, these patterns are generally consistent with each country's revealed comparative advantage.

We found that the productivity gap across French and Japanese exporters systematically differs from the average industry productivity gap: it is *wider* in industries in which Japan has a productivity lead and it is *narrower* in industries in which France has a productivity lead. Such a systematic pattern does not exist for the subset of non-exporting firms. Specifically, the productivity gaps across French and Japanese non-exporters is usually close to the average industry gap but does not differ from this average or from the productivity gap of exporters in any systematic way.

Beyond the set of descriptive evidence, this paper established a formal framework explaining the relationship between international productivity gaps and export participation rates. We show that market selection mechanisms generate truncations in the productivity distribution of firms, which can be consistent with our cross-country comparisons for specific values of the relative trade costs across France and Japan. Under this framework, our data would predict that Japanese firms face, on average, higher relative trade costs than their French counterparts.

Extensions of this research could take several directions. First, one would want to investigate further how country-specific productivity advantages and relative trade costs shape the relationship between a firm's relative productivity and its trade intensity, as opposed to mere export status. Second, provided access to complementary firm-level information on the destination of exports, one would want to investigate the sources of trade cost differences between French and Japanese firms. Comparing the relative productivity of French and Japanese firms that export to the same market, such as the US market, could then be an interesting avenue to pursue.

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Appendix A: Data

Main variables for the TFP computation

The output is defined as the total nominal sales deflated using the industry-level gross output price indices drawn respectively from *INSEE* for France and from the Japan Industrial Productivity (JIP) 2009 database for Japan.[28]

Labour input is obtained by multiplying the number of employees by the average hours worked by industry. Industry level worked hours data are drawn from the EU-KLEMS data set of the Groningen Growth Development Centre (GGDC) for France and from the JIP 2009 database for Japan.[29] Note that in France, a large drop in hours worked occurs from 1999 onwards because of the 35 hours policy: worked hours fell from 38.39 in 1999 to 36.87 in 2000.

The variables for intermediate goods consumption are available both in the *EAE* and in the *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 (industry subscript k and country superscript c are discarded to simplify the notation):

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

where K_{it} is the capital stock for firm i operating in year t; δ_{t-1} is the depreciation rate in year t; I_{it} is the investment of firm i in year t;[30] and p_{It} is the investment goods deflator for industry k.[31] Both the investment price indices and the depreciation rates are available at the 2-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 data set for the firms that entered our data set after 1994.

The cost of intermediate inputs is defined as the nominal 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) (industry subscript k and country superscript c are discarded to simplify

[28] The JIP database has been compiled as a part of a research project by the Research Institute of Economy, Trade, and Industry (RIETI) and Hitotsubashi University. For more details about the JIP database, see Fukao, Hamagata, Inui, Ito, Kwon, Makino, Miyagawa, Nakanishi, and Tokui (2007).

[29] The concordance between the industry-level EU-KLEMS database and the firm-level *EAE* database is performed through the ISIC codes provided in Table A1

[30] 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 the nominal investment.

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

the notation):[32]

$$P_{Kt} = P_{It-1}\tilde{P}_{Kt} + \delta_t P_{It} - [P_{It} - P_{It-1}]. \quad \text{(A-2)}$$

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 the capital gains. The capital revaluation term can be derived from investment price indices. To minimise the impact of sometimes volatile annual changes, three-period annual moving averages are used. The nominal rates of return are the 10-year government bond of France and Japan.

Firm-level data on exports

Exports are also available at the firm level both in the *BSJBSA* and in the *EAE* surveys. However, the export variable has some country specificities. In Japan, one problem is that the definition of exports in the *BSJBSA* changed in 1997. Before 1997, exports included sales by foreign branches (indirect exports). After 1997, exports are defined as exports from the parent firm (direct exports). Total (direct plus indirect) exports are also available between 1997 and 1999. For consistency, this paper focuses on direct exports. Exports before 1997 are adjusted by multiplying the figure by the ratio of direct exports to total exports. The ratio of direct exports is defined as the industry-average ratio of direct exports to total exports between 1997 and 1999.

Concordance tables for different industry classifications

- From the *EAE* to the *BSJBSA*: The industry codes provided in the *EAE* survey are based on the main activity code of the firm (defined as the main 4-digit activity code reported by the firm for the last year of observation). Those codes are drawn from the "*Nomenclature des Activités Françaises*" referenced as NAF rev.1., 2003 by INSEE.[33] The industry codes for Japan are drawn directly from the *BSJBSA* specific nomenclature.

  Table 7 shows how we connected the industry codes of the *EAE* and the *BSJBSA* databases to build our joint FJ industrial classification. Table 7 also shows how each of these codes connects to the International Standard Industrial Classification (ISIC) through the ISIC rev3.1 codes.

  [Table 7 about here.]

- From JIP 2009 to the *BSJBSA*: The industry classification of the *BSJBSA* is not the same as that of the JIP 2009 database from which we extracted the output and the input

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

[33] The NAF rev.1., 2003 nomenclature is available at the following URL: http://www.insee.fr/fr/methodes/default.asp?page=nomenclatures/naf2003/naf2003.htm

price series. If one industry in the *BSJBSA* corresponds to more than one industry in the JIP 2009 database, we aggregate the nominal values and real values from the JIP 2009 database and then divide the aggregate nominal values by the aggregate real values to obtain indices. The concordance of the industry classification between the *BSJBSA* and the JIP 2009 database is presented in Table 8 and Table 9 .

[Table 8 about here.]

[Table 9 about here.]

- From *FJ* to *EUKLEMS* : The last industry classification concordance that we used in this study is a concordance between our FJ classification and the EU-KLEMS classification. To perform this concordance, we used the ISIC codes provided in Table 7. (See Inklaar and Timmer (2008) for additional details on the concordance between the EU-KLEMS industry codes and the ISIC ones.)

Appendix B: TFP Gaps and Revealed Comparative Advantage

In this Appendix, we investigate further the consistency between our TFP gap estimates built from firm-level data and the standard estimates of Revealed Comparative Advantage (RCA). One of the most popular proxies of RCA is that developed by Balassa (1965). This proxy compares a country's share of world exports in an industry to its share of exports overall:

$$RCA^{c,k} = \frac{E^{c,k}/E^{\cdot,k}}{E^{c,\cdot}/E^{\cdot,\cdot}}, \tag{A-3}$$

where $E^{c,k}$ and $E^{\cdot,k}$ are exports from industry k by country c and the world, respectively; $E^{c,\cdot}$ and $E^{\cdot,\cdot}$ are their respective total exports. If $RCA^{c,k}$ is greater than unity, it means that industry k in country c exports more than average. It thus can be interpreted that the industry has comparative advantage.

In Table 10, we present Balassa RCA for France and Japan in 2000 computed relative to the US benchmark at the industry level. In the last column of Table 10, we indicate whether or not the comparative advantages/disadvantages of Japan over France are consistent with our productivity gap estimates.

[Table 10 about here.]

Basically, Table 10 shows that the Balassa RCA indexes are broadly consistent with our TFP gap estimates. Indeed, Japan is usually shown to exhibit a comparative advantage over France in industries in which Japanese firms are, on average, outperforming their French counterparts. However, some striking exceptions appear such as the *Textile* and the *Clothing* industries, in which Japan is shown to exhibit a strong productivity advantage without exhibiting any comparative advantage, at least according to the Balassa index measure. In some other industries, it is the relative magnitude of the comparative advantage and the productivity gap that appears puzzling. For instance, in the *Motor Vehicle* industry, in which Japanese firms were found to outperform their French counterparts by approximately 90 per cent, on average (see Table 1 in the main text), the comparative advantage of Japan is 40 per cent higher than the comparative advantage of France. By contrast, in the *Medical, precision and optical instruments* industry, in which Japanese firms were also found to largely outperform their French counterparts (by 80 per cent on average, according to Table 1), the comparative advantage of Japan is 130 per cent higher than the comparative advantage of France.

Some industry-specific discrepancies between international productivity gaps and international export performance gaps were already pointed out in the pioneering work by Baily and Solow (2001). In particular, these authors emphasised the discrepancy between the productivity and export performances of the Japanese and German Automobile Manufacturers on exactly the same ground. In that respect, the new evidence provided in this paper allows the stylised fact to be extended over a much larger variety of industries. All in all, we interpret those discrepancies as evidence that dimensions of firm heterogeneity (other than mere productivity heterogeneity) matter when explaining cross-country differences in export performance.

Appendix C: Firm Export Behaviour by Size Class, 1994 and 2006

In this Appendix, we refine the statistics on firm export behaviours by firm size class. Specifically, we distinguish SMEs defined as firms with 50 to 249 employees, Intermediate firms as those with 249 to 500 employees and large firms as those with over 500 employees. We also look at the beginning and end of our period of observation, basically the years 1994 and 2006, to see how those statistics have evolved in France compared to Japan over time. The results are displayed in Table 11.

[Table 11 about here.]

Table 11 shows than the largest gap between France and Japan in terms of the extensive margin of international trade is found for the small and medium firms. While 83 per cent of French SMEs were exporting in 1994, only 18 per cent of their Japanese counterparts were also exporting at that time. In contrast, almost 60 per cent of large Japanese firms were exporters in 1994 against 96 per cent of their French counterparts. One interesting feature is that the export intensity increases far less with firm size in Japan than in France. In consequence, the largest gap in terms of the intensive margin of international trade between France and Japan is found for the category of large firms. Table B1 also shows that the concentration of exports among a few top exporters is more pronounced among small and large firms than among intermediate firms. This feature holds both in France and in Japan. Finally, the comparison of the export participation rates and export intensities across two extreme years, 1994 and 2006, show the expected increasing trend in both countries. However, while most of the increase in the export commitment of Japanese firms has proceeded through the extensive margin (i.e., non-exporters becoming exporters), in the French case, most of that increase has proceeded through the intensive margin (exporting firms increasing their export intensity).[34]

[34]Obviously, this trend does not mean than French exporters have not entered new markets. Actually, Mayer and Ottaviano (2008) showed that the largest part of the growth of French exports over the last two decades was due to the increase in the number of markets served by exporting firms.

Appendix D: Size and TFP Cumulative Distributions of Firms, by Industry

In Appendix D, we complement Figure 1 with more detailed statistics at the industry level. Specifically, Figure 4 reports the size cumulative distributions of Japanese and French firms by industry while Figure 5 reports the TFP cumulative distributions for both types of firms.

[Figure 4 about here.]

[Figure 5 about here.]

Appendix E: Proof of the Monotonicity of the Relationship between the Truncated Mean and the Truncation Threshold

To prove that $\frac{\phi(z)}{1-\Phi(z)}$ is a monotonic transformation of z, we must show that the first derivative does not change sign. Define $z = \frac{\theta_{F_X}-\mu}{\sigma}$ and $\Gamma(z) = \frac{\phi(z)}{1-\Phi(z)}$, where $\phi(.)$ and $\Phi(.)$ are the probability density function and the cumulative distribution function of the Standard Normal, respectively. The first derivative of $\Gamma(z)$ with respect to θ_{F_X} yields the following:

$$\frac{\mathrm{d}\Gamma(z)}{\mathrm{d}z} = \frac{\phi'(z)[1-\Phi(z)] + \phi(z)^2}{[1-\Phi(z)]^2}. \tag{A-4}$$

Because of the squared terms, the denominator is always positive. Concerning the numerator, $\phi(z)^2$ is always positive, so that the sign of Equation A-5 depends on the left hand expression of the numerator. Because Φ is the Normal cdf, we know that $\Phi \in [0,1]$, which implies that $1-\Phi$ is always positive. Likewise, ϕ, the Normal pdf, is always positive.

The problem boils down to the sign of $\phi'(z)$. Because $\phi(z) = \frac{1}{\sigma\sqrt{2\pi}}e^{-\frac{1}{2}z^2}$, observe that $\phi'(z) = -\frac{z}{\sigma}\phi(z)$. Hence,

$$\frac{\mathrm{d}\Gamma(z)}{\mathrm{d}z} = \frac{-\frac{z}{\sigma}\phi(z)[1-\Phi(z)] + \phi(z)^2}{[1-\Phi(z)]^2} \tag{A-5}$$

Recall that $\frac{z}{\sigma} = \frac{\theta_{F_X}-\mu}{\sigma^2}$. One must therefore envisage three situations:

1. $\theta_{F_X} < \mu$. This relationship implies that $-\frac{z}{\sigma}$ is positive. Hence, $-\frac{z}{\sigma}\phi(z)[1-\phi(z)] > 0$ and $\mathrm{d}\Gamma(z)/\mathrm{d}z > 0$.

2. $\theta_{F_X} = \mu$. This relationship implies that $-\frac{z}{\sigma} = 0$ is nil. Hence, $-\frac{z}{\sigma}\phi(z)[1-\phi(z)] = 0$ and $\mathrm{d}\Gamma(z)/\mathrm{d}z > 0$.

3. $\theta_{F_X} > \mu$. This relationship implies that $-\frac{z}{\sigma}$ is negative. Rewrite $\frac{z}{\sigma}\phi(z)[1-\phi(z)] = \sigma^{-1}[-z\phi(z) + z\phi(z)]$. Therefore, to prove that $[-z\phi(z) + z\Phi(z)] > 0$ is tantamount to proving that $z\Phi(z) > z\phi(z)$. Observe that both ϕ and Φ are continuous functions. Hence, to verify that $z\Phi(z) > z\phi(z)$ when $z > 0$, we need to show, first, that $\Phi(0) > \phi(0)$ and second, that $\mathrm{d}\Phi(z)/\mathrm{d}z > \mathrm{d}\phi(z)/\mathrm{d}z \quad \forall\, z \in \Re^{+}$.

   - Because Φ and ϕ is the standard normal cdf and pdf, one knows that $\Phi(0) > \phi(0)$ when $z = 0$;
   - $\mathrm{d}\Phi(z)/\mathrm{d}z = \phi(z) > 0$. However $\mathrm{d}\phi(z)/\mathrm{d}z < 0$ when $z \in \Re^{+}$. This relationship implies that $\mathrm{d}\Phi(z)/\mathrm{d}z > \mathrm{d}\phi(z)/\mathrm{d}z$

   Therefore $\frac{z}{\sigma}\phi(z)[1-\phi(z)] > 0$.

The above implies that the numerator $\phi'(z)[1-\phi(z)]+\phi(z)^2$ is always positive. Therefore, $\frac{\phi(z_1)}{1-\Phi(z_1)} > \frac{\phi(z_2)}{1-\Phi(z_2)} \quad \forall\, z_1 > z_2$. ■

Table 1: Japan-France Productivity Gaps, Firm-level Databases, 2006

	JP			FR			JP/FR
Industry	N	Mean	St.dev.	N	Mean	St.dev.	Relative TFP
Textiles	173	1.39	0.133	303	0.66	0.144	2.12
Clothing	158	1.34	0.173	314	0.72	0.162	1.85
Manufacture of wood	87	0.81	0.090	191	1.26	0.109	0.64
Pulp and paper	268	1.13	0.093	267	0.94	0.101	1.20
Printing and publishing	539	0.99	0.149	474	1.07	0.198	0.92
Chemical products	640	1.01	0.148	659	1.28	0.176	0.79
Rubber and plastic	535	0.55	0.097	696	1.65	0.129	0.33
Non-metallic mineral products	322	0.79	0.155	322	1.29	0.174	0.61
Basic metal products	508	1.05	0.147	260	0.96	0.106	1.09
Fabricated metal products	626	1.01	0.136	1010	1.04	0.119	0.97
Machinery and equipment	966	1.11	0.124	908	1.11	0.144	1.00
Machinery for office and services	89	1.55	0.118	20	1.09	0.138	1.43
Electric machinery and apparatus	699	1.46	0.170	484	1.15	0.176	1.27
Communication equipment and related products	46	1.61	0.118	89	1.57	0.180	1.03
Medical precision and optical instruments	356	1.41	0.151	336	1.09	0.263	1.30
Motor vehicles	614	1.38	0.097	270	0.74	0.139	1.87
Other transportation equipment	153	1.35	0.122	160	0.70	0.193	1.92
Furniture and other manufacturing	265	1.03	0.179	365	1.27	0.142	0.81

Notes: This table presents the unweighted mean of the distributions of firm TFP for each country. TFP is measured in logarithm.

Table 2: France-Japan TFP Comparisons: Industry-Level Data versus Firm-Level Data. Benchmark Year 1997

EU KLEMS industries	EU-KLEMS classification	FJ classification	JP/FR GGDC	JP/FR Our team
Textiles; textile products; leather and footwear	17t19	1t2	1.13	2.25
Wood and products of wood and cork	20	3	0.75	0.67
Pulp; paper; paper products. printing and publishing	21t22	4t5	1.00	1.11
Chemicals and chemical products	24	6	0.80	0.74
Rubber and plastics products	25	7	0.50	0.31
Non-metallic mineral products	26	9t10	0.75	0.56
Basic metals and fabricated metal products	27t28	8	0.95	1.00
Machinery. nec	29	11	0.99	0.97
Transport equipment	34t35	16t17	1.28	1.84
Electrical and optical equipment	30t33	13t15	1.19	1.41
Manufacturing nec; recycling	36t37	18	0.78	0.76

Note: The GGDC series are sourced from http://www.ggdc.net/databases/levels.htm. Our team series are based on our own (firm-level) TFP computations. Specifically, column 4 reports the ratio of the unweighted means of, respectively, the Japanese and the French firms' TFP distributions computed for the benchmark year 1997. Those ratios are first computed at the level of our 18 FJ industries and then aggregated into the 11 EU-KLEMS industries as unweighted means.

Table 3: Exporters and Non-Exporters, France and Japan, by Industry, 1994–2006

			Export participation		Export intensity	
	JP	FR	JP	FR	JP	FR
Industry	N	N	Per cent	Per cent	Mean	Mean
All Manufacturing	100744	102004	27.5	84.6	11.5	26.4
Textiles	3148	5810	13.1	85.6	9.0	30.6
Clothing	6743	6743	6.9	72.9	7.7	22.4
Manufacture of wood	1345	2557	5.7	71.1	0.6	22.8
Pulp and paper	3728	3977	7.3	89.1	13.8	22.9
Printing and publishing	6948	6604	6.4	71.4	5.8	9.3
Chemical products	8576	8904	45.0	94.0	7.3	32.3
Rubber and plastic	6339	8538	22.9	83.9	6.3	19.2
Non-metallic mineral products	5127	4565	18.5	75.5	7.8	26.1
Basic metal products	6721	3652	23.6	92.5	7.3	35.4
Fabricated metal products	8786	13083	18.8	84.2	5.9	18.5
Machinery and equipment	12349	13260	44.8	86.9	13.1	33.5
Machinery for office and services	1430	423	34.9	97.3	16.4	47.9
Electric machinery and apparatus	12186	6696	34.8	85.8	15.6	30.4
Communication equipment and products	2148	1394	31.1	73.2	18.4	30.7
Medical precision and optical instruments	4716	4522	51.8	92.2	14.3	34.6
Motor vehicles	8217	3483	24.8	90.5	8.3	28.6
Other transportation equipment	1979	2087	31.7	87.3	23.9	33.9
Furniture and other manufacturing	3712	5706	27.8	92.3	15.2	22.2

Source: Authors' own calculations. Export participation is the percentage of exporting firmsthe percentage of exporting firm-year over the period of observation . Export intensity is computed as the mean ratio of exports over sales for the exporting firms only.

Table 4: TFP Export Premium, by Size Class, 1994–2006

	France		Japan	
	N	Export premium	N	Export premium
Size class		β (p value)		β (p value)
All manufacturing firms	99 963	0.0138	100 744	0.056
		0.000		0.000
SMEs (50–249)	75 850	0.0103	71 452	0.038
		0.000		0.000
Intermediate (250–499)	13 232	-0.0003	14 919	0.031
		0.398		0.000
Large (+500)	10 881	0.0050	14 373	0.026
		0.280		0.000

Note: β is the estimated regression coefficient from an OLS-regression of log (TFP) on a dummy variable for exporting firms, controlling for a full set of the interaction terms of industry dummies and year dummies. The regression is first computed on the entire set of manufacturing firms in each country, and then separately on each subset of firms belonging to a specific size class.
Source: Authors' own calculations.

Table 5: Productivity Level Differences between French and Japanese Firms by Industry and by Export Status

	All firms			Exporters			Non-exporters		
	JP mean	FR mean	TFP difference	JP mean	FR mean	TFP difference	JP mean	FR mean	TFP difference
All Manufacuring	1.04	1.02	0.02***	1.07	1.02	0.05***	1.02	1.01	0.01***
Textiles	1.31	0.59	0.72***	1.37	0.59	0.78***	1.30	0.57	0.72***
Clothing	1.23	0.61	0.62***	1.34	0.61	0.73***	1.22	0.60	0.62***
Manufacture of wood	0.78	1.19	−0.41**	0.80	1.18	−0.38***	0.77	1.20	−0.42***
Pulp and paper	1.08	0.90	0.18***	1.11	0.89	0.22***	1.07	0.91	0.17***
Printing and publishing	0.96	1.00	−0.04***	1.01	1.00	0.00	0.96	1.00	−0.04***
Chemical products	0.90	1.19	−0.29***	0.93	1.19	−0.27***	0.87	1.16	−0.29***
Rubber and plastic	0.49	1.58	−1.09***	0.52	1.58	−1.06***	0.48	1.56	−1.09***
Non-metallic mineral products	0.72	1.27	−0.55***	0.76	1.27	−0.51***	0.71	1.25	−0.55***
Basic metal products	1.02	0.94	0.08***	1.05	0.94	0.10***	1.01	0.93	0.07***
Fabricated metal products	0.95	1.04	−0.09***	0.97	1.04	−0.07***	0.94	1.03	−0.09***
Machinery and equipment	1.00	1.04	−0.04***	1.02	1.04	−0.01***	0.97	1.02	−0.05***
Machinery for office and services	1.38	0.88	0.51***	1.45	0.88	0.57***	1.35	0.85	0.50***
Electric machinery and apparatus	1.27	0.94	0.33***	1.31	0.94	0.37***	1.24	0.91	0.33***
Communication equipment and related products	1.28	1.17	0.12***	1.34	1.17	0.17***	1.25	1.15	0.11***
Medical precision and optical instruments	1.26	0.93	0.33***	1.28	0.93	0.35***	1.23	0.91	0.32***
Motor vehicles	1.32	0.68	0.64***	1.35	0.68	0.67***	1.30	0.62	0.68***
Other transportation equipment	1.23	0.68	0.55***	1.28	0.69	0.59***	1.21	0.64	0.57***
Furniture and other manufacturing	0.89	1.17	−0.27***	0.95	1.17	−0.22***	0.87	1.10	−0.23***

Notes: In this table, we report the differences between the mean TFP levels (in logarithm) of Japanese and French firms. Positive values indicate that Japanese firms outperform their French counterparts. *** and ** indicate statistical significance at the 1 and 5 per cent levels, respectively.

Table 6: Kolmogorov-Smirnov Test for Stochastic Dominance of G(JP) over G(FR)

	All firms		Exporters		Non-exporters	
	Distance	Critical probability	Distance	Critical probability	Distance	Critical probability
All Manufacturing	−0.081	0.000	−0.199	0.000	−0.079	0.000
Textiles	−0.981	0.000	−1.000	0.000	−0.960	0.000
Clothing	−0.922	0.000	−0.989	0.000	−0.896	0.000
Manufacture of wood	0.975	0.000	0.989	0.000	0.977	0.000
Pulp and paper	−0.715	0.000	−0.788	0.000	−0.708	0.000
Printing and publishing	0.077	0.000	−0.105	0.000	0.068	0.000
Chemical products	0.749	0.000	0.727	0.000	0.698	0.000
Rubber and plastic	0.999	0.000	0.999	0.000	0.998	0.000
Non-metallic mineral products	0.963	0.000	0.938	0.000	0.981	0.000
Basic metal products	−0.347	0.000	−0.436	0.000	−0.361	0.000
Fabricated metal products	0.309	0.000	0.239	0.000	0.325	0.000
Machinery and equipment	0.137	0.000	0.067	0.000	0.181	0.000
Machinery for office and services	−0.874	0.000	−0.935	0.000	−0.989	0.000
Electric machinery and apparatus	−0.669	0.000	−0.740	0.000	−0.685	0.000
Communication equipment and related products	−0.369	0.000	−0.481	0.000	−0.362	0.000
Medical precision and optical instruments	−0.703	0.000	−0.742	0.000	−0.674	0.000
Motor vehicles	−0.986	0.000	−0.996	0.000	−0.972	0.000
Other transportation equipment	−0.931	0.000	−0.968	0.000	−0.920	0.000
Furniture and other manufacturing	0.718	0.000	0.639	0.000	0.631	0.000

Notes: Negative distance implies the first order stochastic dominance of G(JP) with respect to G(FR), so that the distribution of Japanese firms lies to the right of the distribution of French firms.

Table 7: EAE-ISIC-BSJBSA Industry Concordance Table and FJ Classification

FJ Classification		Industry concordance		
Code	Industry	JP	ISIC	FR
1	Textiles	141-143; 149	17.11-17; 17.21-25; 17.60-72; 17.30; 17.40-54	171A-C-E-F-H-K-M-P; 172A-C-E-G-J; F23; 173Z;F22
2	Clothing	151-152; 240	18-19	C1
3	Manufacture of wood	161;169	20.10-52	F31
4	Pulp and paper	181-182	21.11-25	F32-F33
5	Printing and publishing	191-193	22.11-13; 22.15	221A-C-E-J; 222A-C-E-G-J
6	Chemical products	201-205; 209	24.11-15; 24.20-64; 24.66-70	F41; F43-F44; 241G; C31- C32
7	Rubber and plastic	220; 231; 239	24.16; 24.65; 25.21-24; 24.17; 25.11-13	241L; 241N; F45-F46
8	Non-metallic mineral products	251- 252	26.11-15; 26.51; 26.61;26.63; 26.65; 26.21-40;26.52-53; 26.64; 26.70-82	F13; 265A-C-E; 266A-G-E-J-L;263L; 262A-C-E-G-J-L; 264A-B-C;267Z; 268A-C
9	Basic metal products	261-262; 271-272	27.10-35; 27.51-54; 27.41-45;	F51, 275A-C; F52; 275E-G
10	Fabricated metal products	281; 289	28.11-21; 28.40-75	E21; F54- F55
11	Machinery and equipment	291-292; 299	29.40; 29.51; 29.31-32; 29.52-56; 28.22-29.22; 29.24	E26-E27; E22- E23; E24 (except 292F)
12	Machinery for office and services	293	29.23; 30.01	292F; 300A
13	Electric machinery and apparatus	301-302; 304-205	31.10; 30.02; 31.20-50;31.61-62; 29.71; 32-10	E32; 300C; F6; 297A
14	Communication equipment and products	303	32.20-30; 33.20-30	C45; E33
15	Medical, precision and optical instruments	321-323; 309; 329	33.10-50	E34; E35; 334A-B; 335Z
16	Motor vehicles	311	34.10-34.30	D0
17	Other transportation equipment	319	35.11-35.50	E1
18	Furniture and other manufacturing	170; 340	29.72; 36.11-15; 22.14; 22.31-33; 36.21-63	297C; C41; 221 E-G;223A-E; C42; C43

Notes: The Japanese codes (JP) are based on the BSJBSA codes for the year 2006. The international codes (ISIC) are based on ISIC rev.3.1. The French codes (FR) available in the EAE survey are based on NAF rev.1., 2003.

Table 8: BSJBSA-JIP Industry Concordance Table

BSJBSA		JIP	
Code	Industry	Code	Industry
141	Silk reeling plants, spinning mills	15	Textile products
142	Woven fabric mills, knit fabric mills	15	Textile products
143	Dyed and finished textiles	15	Textile products
149	Miscellaneous textile and mill products	15	Textile products
151	Textile and knitted garments	15	Textile products
152	Accessories, miscellaneous fabricated textile products	15	Textile products
161	Sawing, planning mills, plywood	16	Lumber and wood products
169	Miscellaneous manufacture of wood products	16	Lumber and wood products
170	Manufacture of furniture and fixtures	17	Furniture and fixtures
181	Manufacture of pulp and paper	18	Pulp, paper, and coated and glazed paper
182	Manufacture of paper worked products	19	Paper products
191	Newspaper publishers	92	Publishing
192	Publishers	92	Publishing
193	Printing and allied industries	20	Printing, plate making for printing and bookbinding
201	Chemical fertilizers, industrial inorganic chemicals	23	Chemical fertilizers
202	Industrial organic chemicals	25	Basic organic chemicals
204	Oil and fat products, soaps, detergents, surface-active agents and paints	28	Miscellaneous chemical products
205	Drugs and medicines	29	Pharmaceutical products
209	Miscellaneous chemicals and allied products	28	Miscellaneous chemical products
211	Petroleum refining	30	Petroleum products
219	Miscellaneous petroleum and coal products	30	Petroleum products
220	Manufacture of plastic products	58	Plastic products
231	Tires and inner tubes	22	Rubber products
239	Miscellaneous rubber products	22	Rubber products
240	Manufacture of leather tanning, leather products and fur skins	21	Leather and leather products
251	Glass and its products	32	Glass and its products
252	Cement and its products	33	Cement and its products
259	Miscellaneous ceramic, stone and clay products	35	Miscellaneous ceramic, stone and clay products
261	Iron castings, unprocessed steel , steel materials	36	Pig iron and crude steel
262	Miscellaneous iron and steel	37	Miscellaneous iron and steel

Table 9: BSJBSA-JIP Industry Concordance Table (Cont'd)

BSJBSA		JIP	
Code	Industry	Code	Industry
271	Smelting and refining of non-ferrous metals	38	Smelting and refining of non-ferrous metals
272	Non-ferrous metal products	39	Non-ferrous metal products
281	Fabricated constructional and architectural metal products	40	Fabricated constructional and architectural metal products
289	Miscellaneous fabricated metal products	41	Miscellaneous fabricated metal products
291	Metal working machinery	42	General industry machinery
292	Special industry machinery	43	Special industry machinery
293	Office and service industry machines	45	Office and service industry machines
299	Miscellaneous machinery and machine parts	44	Miscellaneous machinery
301	Industrial electric apparatus	46	Electrical generating, transmission, distribution and industrial apparatus
302	Household electric appliances	47	Household electric appliances
303	Communication equipment and products	49	Communication equipment
304	Electronic data processing machines, digital and analog computers, equipment and accessories	50	Electronic equipment and electric measuring instruments
305	Electronic parts and devices	52	Electronic parts
309	Miscellaneous electronic parts	53	Miscellaneous electrical machinery equipment
311	Motor vehicles, parts and accessories	54	Motor vehicles
319	Miscellaneous transportation equipment	56	Other transportation equipment
321	Medical instruments and apparatus	57	Precision machinery and equipment
322	Optical instruments and lenses	57	Precision machinery and equipment
323	Watches, clocks, clockwork-operated devices and parts	57	Precision machinery and equipment
329	Miscellaneous precision instruments and machinery	57	Precision machinery and equipment
330	Manufacture of ordnance and accessories	59	Miscellaneous manufacturing industries
340	Miscellaneous manufacturing industries	59	Miscellaneous manufacturing industries

Table 10: Revealed Comparative Advantage (RCA) for France and Japan, 2006

		RCA		Consistent
Industry	JP	FR	JP/FR	with TFP gaps
Textiles	0,768	0,508	0,662	no
Clothing	0,784	0,049	0,063	no
Manufacture of wood	0,663	0,014	0,021	yes
Pulp and paper	1,202	0,270	0,225	no
Printing and publishing	1,162	0,302	0,260	no
Chemical products	1,524	0,936	0,614	yes
Rubber and plastic	1,263	1,235	0,978	yes
Non-metallic mineral products	1,209	1,028	0,850	yes
Basic metal products	0,909	1,069	1,176	yes
Fabricated metal products	1,070	0,657	0,614	yes
Machinery and equipment	1,302	1,941	1,491	no
Machinery for office and services	1,057	1,987	1,880	yes
Electric machinery and apparatus	0,595	1,352	2,272	yes
Communication equipment and related products	0,678	0,792	1,170	yes
Medical, precision and optical instruments	1,057	1,776	1,681	yes
Motor vehicles	1,479	2,435	1,647	yes
Other transportation equipment	2,652	1,333	0,502	no
Furniture and other manufacturing	0,670	0,412	0,614	yes

Note: For the definition of RCA, see the main text. Source: Authors' own calculations from the export data obtained from the UN Comtrade database.

Table 11: Firm Export Behaviour by Firm Class Size, 1994 and 2006

			Export participation	Export Intensity		Share of exports		
Country		N	Percent	Mean	Standard deviation	Top 1 per cent	Top 5 per cent	Top 10 per cent
France								
1994	SME (50–249)	6 238	83,1	21,1	22,8	16,6	39,1	54,6
	Intermediate (250–499)	991	92,6	28,7	24,7	11,8	30,7	44,6
	Large (+500)	785	95,9	33,0	23,4	32,8	55,1	67,0
2006	SME (50–249)	5 406	84,1	27,1	26,8	19,2	40,5	55,6
	Intermediate (250–499)	952	92,4	35,2	28,3	10,6	31,1	46,1
	Large (+500)	794	96,1	40,3	28,6	36,1	56,8	67,2
Japan								
1994	SME (50–249)	5 396	17,9	11,0	14,8	42,9	81,3	95,9
	Intermediate (250–499)	1 177	33,1	9,8	14,2	23,2	64,2	84,7
	Large (+500)	1203	59,7	13,1	16,5	51,5	80,8	90,4
2006	SME (50–249)	5 185	26,4	12,0	16,8	37,0	75,8	91,2
	Intermediate (250–499)	1 042	47,1	12,7	17,4	24,2	58,7	76,2
	Large (+500)	989	66,0	17,3	19,2	47,5	76,9	87,8

Source: Authors' own calculations. Export participation is the percentage of exporting firmsis the percentage of exporting firm-year over the period of observation . Export intensity is computed as the mean ratio of Exports over Sales for the exporting firms only. Share of Exports is the share of total exports provided by the 1, 5, and 10 per cent of the largest exporters

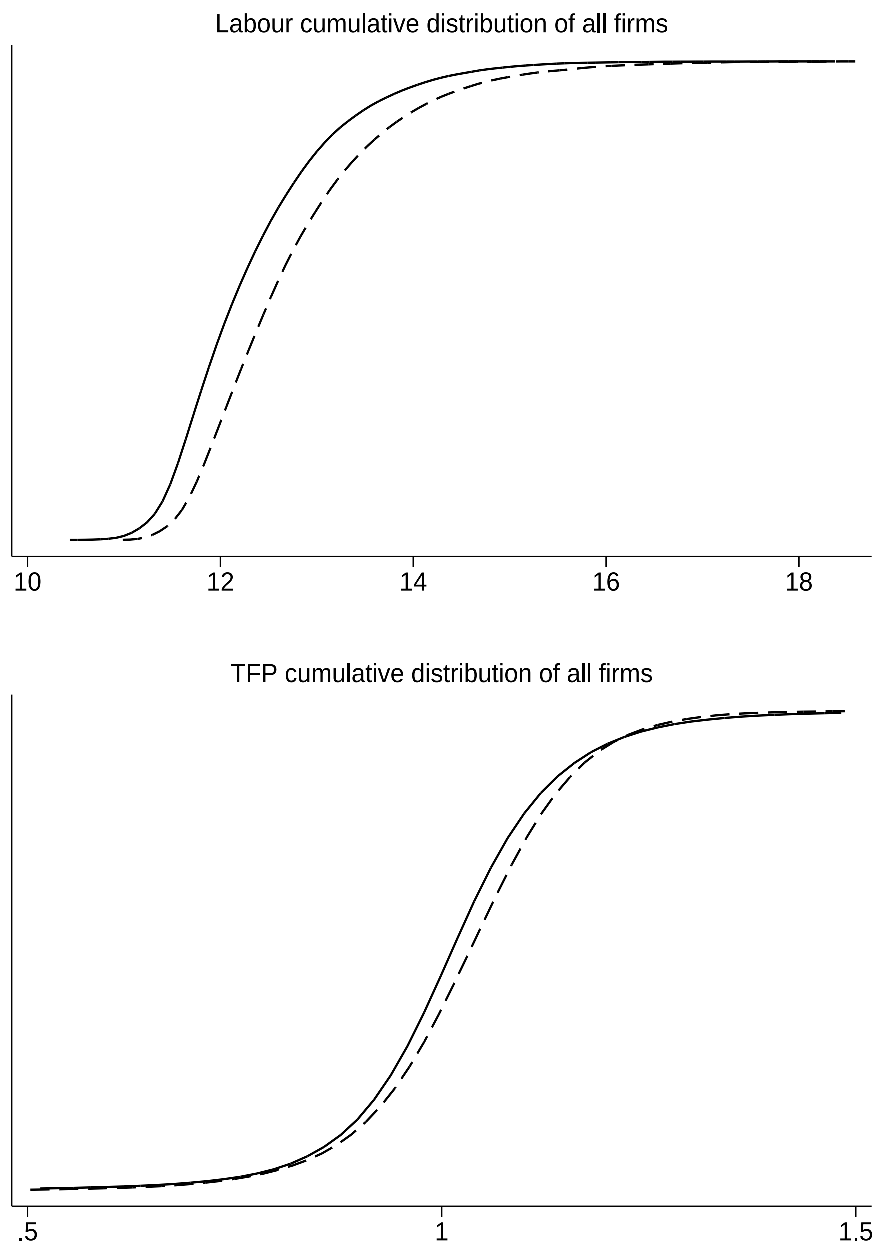

Figure 1: Cumulative Size and TFP Distributions of Manufacturing Firms: France (solid line) and Japan (dashed line), 1994–2006

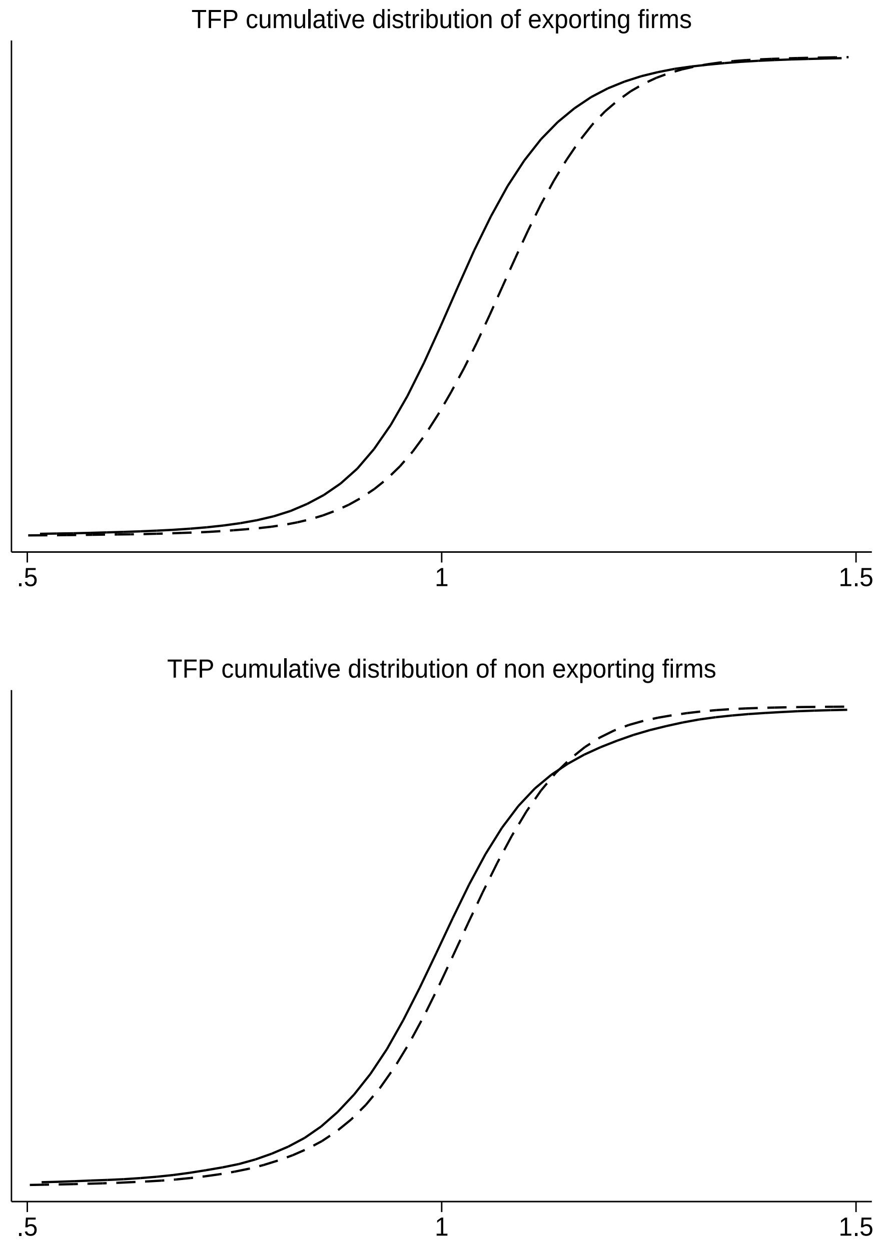

Figure 2: Cumulative TFP Distributions of Manufacturing Firms by Export Status: France (solid line) and Japan (dashed line), 1994–2006

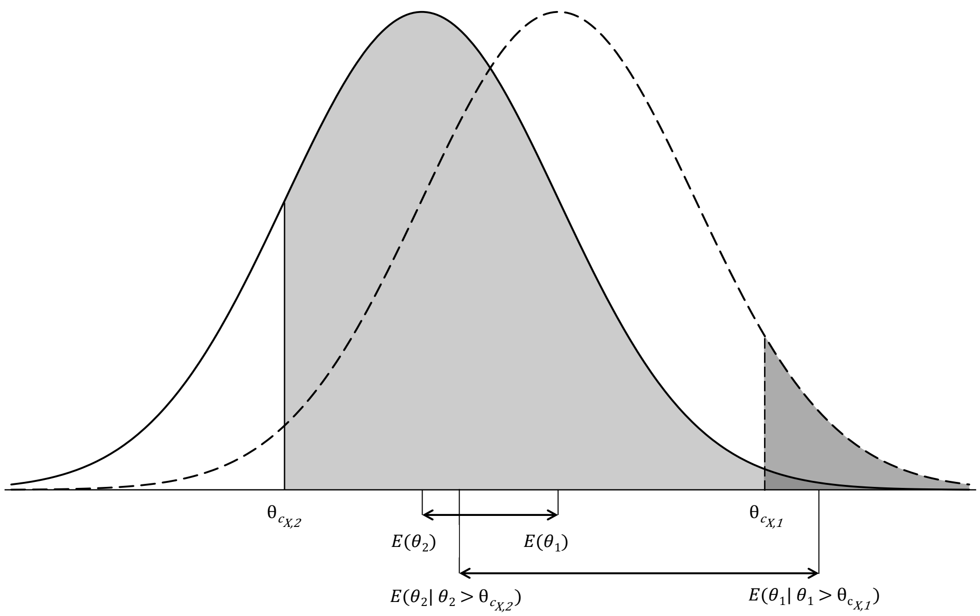

Figure 3: Productivity Gaps as a Function of Export Threshold Values

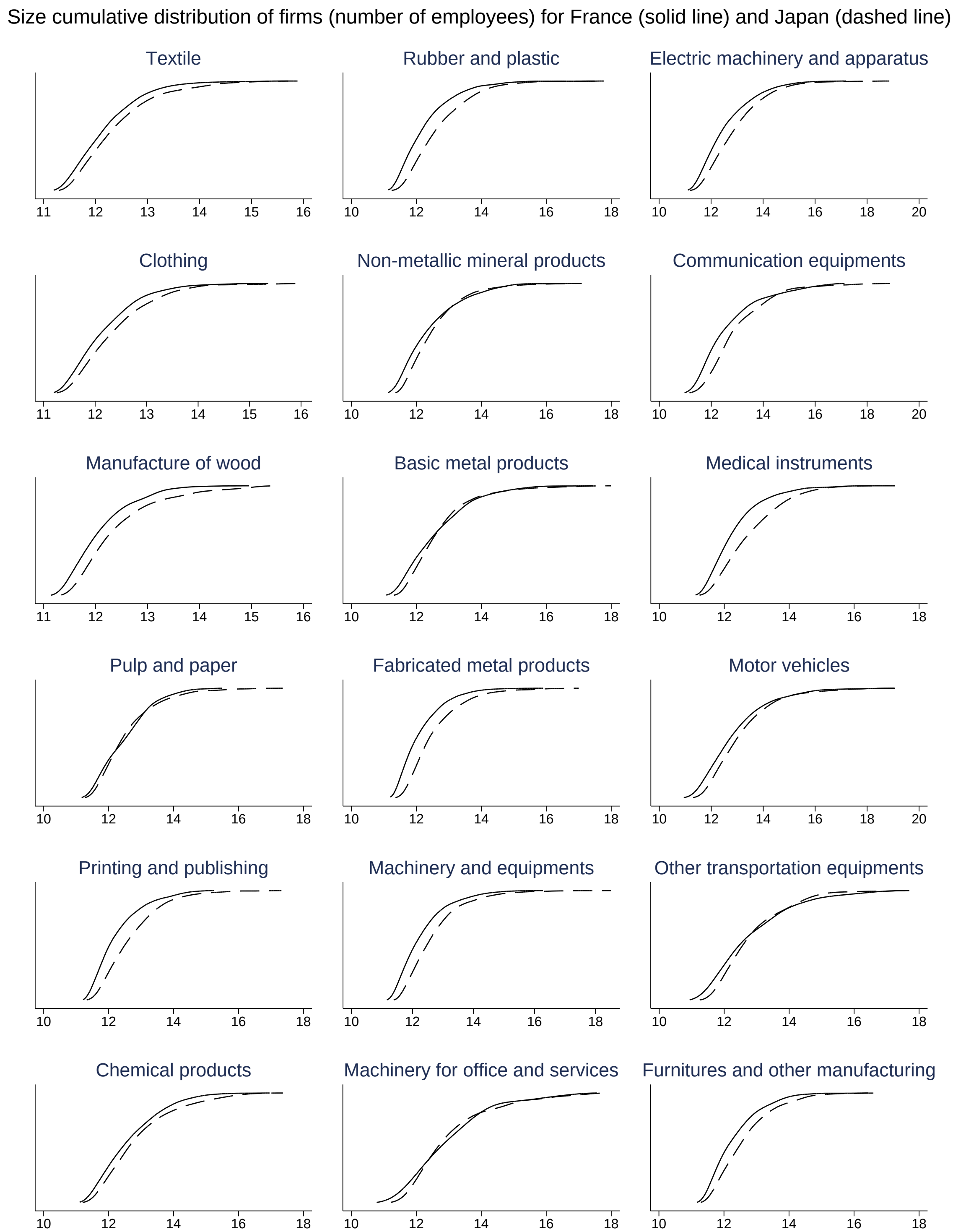

Figure 4: Size Cumulative Distributions of Manufacturing Firms by Industry: France (solid line) and Japan (dashed line), 1994–2006

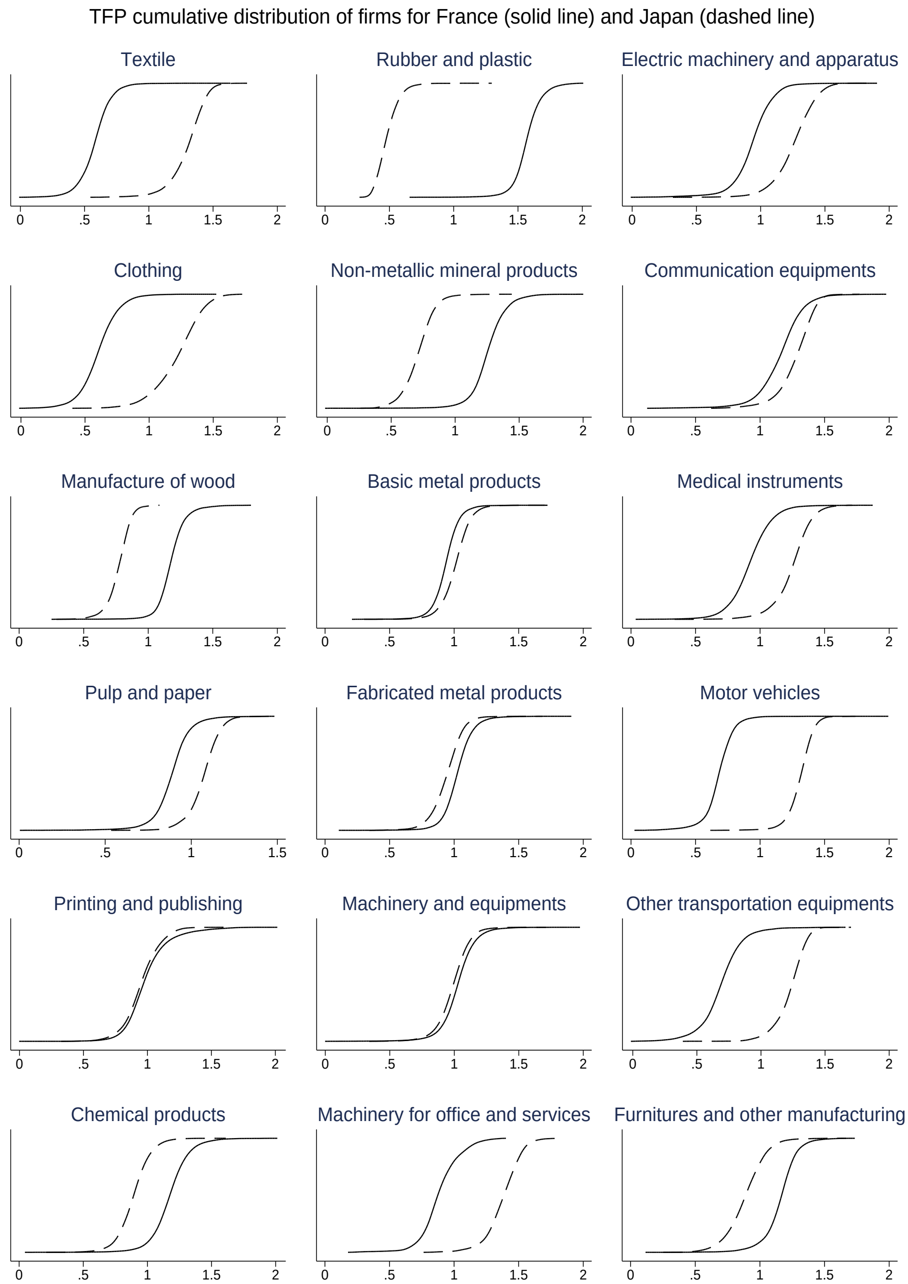

Figure 5: TFP Cumulative Distributions of Manufacturing Firms by Industry: France (solid line) and Japan (dashed line), 1994–2006