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EVIDENCE FROM FRANCE AND JAPAN

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International Productivity Gaps and the Export Status of Firms:
Evidence from France and Japan

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Abstract

This paper provides new evidence on 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 face, on average, higher trade costs than French firms.

Key words: International productivity gap; Exports; Firm heterogeneity; Trade costs; Productivity distribution

JEL classification code: F1, D24

Highlights

• We measure productivity gaps between France and Japan using firm-level data.
• We compare the distributions of firm-level total factor productivity.
• We find that the productivity gaps are sensitive to the export status of firms.
• We explain the link between the productivity gaps and export participation rates.


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1 Introduction

Are firms which compete on international markets closer in terms of productive efficiency than purely domestic firms? To answer 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. 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. 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. Only a few of the previous studies have provided comparisons of the entire distributions of firm productivity.

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

2 Fukao, Imi, Kabe, and Liu (2008) compared the productivity of listed firms in China, Japan, and South Korea. Fukao, Imi, 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.

3 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.\(^4\)

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.\(^5\) 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.\(^6\) 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.\(^7\) 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 differences.

\(^4\)For France and Japan specifically, this previous study provides an estimate of the average productivity gap for the \textit{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).


\(^6\)The ISGEP study includes France, but not Japan.

\(^7\)Following Delgado, Farías, and Ruano (2002) and Farías 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.

The rest of the 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. 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. In the case of France and Japan, both the French National Statistical Office (INSEE) for France and the Ministry of Trade, Economy and Industry (METI) for Japan impose these restrictions on the use of their comprehensive micro-level data sets.

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.
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).\(^9\)

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.\(^{10}\) 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 rm 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 rm. The reference firms are then chain-linked over time. Hence, the index measures the TFP of each rm in year \(t\) relative to that of the reference rm in the initial year \((t = 0)\).

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

\[
\theta_{it}^k - \theta_{rt}^k \approx \left(\ln Y_{it}^k - \ln Y_{rt}^k\right) + \sum_{\tau=1}^{t} \left(\ln Y_{r\tau}^k - \ln Y_{r\tau-1}^k\right) - \sum_{j \in \{K,L,M\}} \frac{1}{2} \left(s_{ijt}^k + \bar{s}_{rjt}^k\right) \left(\ln j_{it}^k - \ln j_{rt}^k\right) + \sum_{\tau=1}^{t} \sum_{j \in \{K,L,M\}} \frac{1}{2} \left(s_{r\tau}^k + \bar{s}_{r\tau-1}^k\right) \left(\ln j_{r\tau}^k - \ln j_{r\tau-1}^k\right),
\]

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

---

\(^9\)A number of studies on rm 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 Nishimura, Nakajima, and Kiyota (2005), for example.

\(^{10}\)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.
of factor $j$, respectively for firm $i$ in industry $k$. $\ln Y_{rt}^k$, $\ln j_{rt}^k$ 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. Let us then 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):

$$\theta_{it}^{JP} - \theta_{r0}^{FR} \approx \left( \ln Y_{it}^{JP} - \ln Y_{rt}^{FR} \right) + \sum_{\tau=1}^{t} \left( \ln Y_{r\tau}^{FR} - \ln Y_{r\tau-1}^{FR} \right)$$

$$- \sum_{j \in \{K,L,M\}} \frac{1}{2} \left( s_{ijt}^{JP} + \bar{s}_{rjt}^{FR} \right) \left( \ln j_{it}^{JP} - \ln j_{rt}^{FR} \right)$$

$$+ \sum_{\tau=1}^{t} \sum_{j \in \{K,L,M\}} \frac{1}{2} \left( \bar{s}_{rj\tau}^{FR} + \bar{s}_{rj\tau-1}^{FR} \right) \left( \ln j_{r\tau}^{FR} - \ln j_{r\tau-1}^{FR} \right),$$

where $\ln Y_{it}^{JP}$, $\ln j_{it}^{JP}$, and $s_{ijt}^{JP}$ are defined as previously but are now specific to Japan. $\ln Y_{rt}^{FR}$, $\ln j_{rt}^{FR}$, 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 $\sigma^c_{\theta}$ and $\bar{\sigma}^c_{\theta}$ are unknown and $\sigma^c_{\theta} \neq \sigma^c_{\theta}$, the $t$-statistic is as follows:

$$
t_{df=(n_{JP}+n_{FR})} = \frac{\bar{\theta}^JP - \bar{\theta}^FR}{\sqrt{\frac{s^2_{JP}}{n_{JP}} + \frac{s^2_{FR}}{n_{FR}}}} \tag{3}
$$

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.$^{11}$

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 $\theta \in \mathbb{R}^+$, with strict inequality for some $\theta$. 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:

$$
H_0 : \ G^{JP}(\theta) - G^{FR}(\theta) = 0 \ \forall \ \theta \in \mathbb{R}^+
$$

$$
H_1 : \ G^{JP}(\theta) - G^{FR}(\theta) \neq 0 \ \text{for some } \theta \in \mathbb{R}^+. \tag{4}
$$

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:

$$
H_0 : \ G^{JP}(\theta) - G^{FR}(\theta) = 0 \ \forall \ \theta \in \mathbb{R}^+
$$

$$
H_1 : \ G^{JP}(\theta) - G^{FR}(\theta) < 0 \ \text{for some } \theta \in \mathbb{R}^+. \tag{5}
$$

$^{11}$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.
Let $\theta_i$ 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:

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

and

$$KS_2 = \sqrt{\frac{n_{FR} \cdot n_{JP}}{N}} \max_{1 \leq i \leq N} \{G^{JP}(\theta_i) - G^{FR}(\theta_i)\},$$ \hspace{1cm} (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.\(^{12}\)

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:

$$\tilde{\theta}^{c,k}_{it} = \theta^{c,k}_{it} - \bar{\theta}^{c,k} + \bar{\theta}^{c,k},$$ \hspace{1cm} (8)

where $c$ and $k$ represent country $c \in \{FR, JP\}$ and industry $k$, respectively. Hence, $\tilde{\theta}^{c,k}_{it}$ is the average TFP performance in industry $k$ for country $c$ for a given year $t$, whereas $\bar{\theta}^{c,k}$ is 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 $\bar{\theta}$, not the mean specific to the industry to which the firm belongs $(\bar{\theta}^{c,k})$. In Section 5 below, we present the results of the KS-tests performed on the empirical

\(^{12}\)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.
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

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 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, 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.\(^{13}\)

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,\(^{14}\) 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. The precise definition of each of our main variables and the methodology we implemented to make these variables comparable across France and Japan is fully described in Appendix A.

\(^{13}\)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 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.

\(^{14}\)Because of the high comparability of the firm-level data in Japan and France, a recent international comparative study by Dobbelare, Kiyota, and Mairesse (2013) also utilised the EAE and the BSJBSA.
This data implementation step allowed us to construct 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.

4 Average Industry Productivity Gaps Built from Firm-Level Data

The most detailed productivity gap estimates that exist at the industry level are the ones recently compiled by GGDC from the industry-level 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 rely on a more detailed industrial classification as firms are categorised in 18 different manufacturing industries instead of 11 for the corresponding EU-KLEMS industry coverage.

Table 1 presents the mean and standard deviation of the TFP distributions in Japan and France separately for each of our 18 industries. 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. Another concern is 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).

To check the consistency between our estimates and the estimates built by GGDC, we use concordance tables to aggregate our data into the industries of the EU-KLEMS database\textsuperscript{15}. 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.\textsuperscript{16}

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 (\textit{Textiles, textile products, leather, and footwear, Transport equipment, and Electrical and optical equipment}) while France has the productivity lead in five industries (\textit{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 \textit{Basic metals and fabricated metal products} and the \textit{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. The strongest difference exists for the \textit{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 dispersion of the TFP measures based on firm-level data is larger than the dispersion of the TFP measures based on industry-level data. In consequence, the average productivity gaps computed from firm-level data are systematically larger than the average productivity gaps computed from 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.\textsuperscript{17}

\textsuperscript{15}The concordance tables are available in the Appendix A of the working paper version of our paper (Bellone, Kiyota, Matsuura, Musso, and Nesta, 2013)

\textsuperscript{16}We had to exclude the \textit{Food products, beverages, and tobacco} industry and the \textit{Coke, refined petroleum products, and nuclear fuel} industries, for which we lacked firm-level data in the \textit{EAE} and/or the \textit{BSIBSA} surveys. We also excluded the \textit{Post and Communications} industry, which is not part of manufacturing and for which we do not have corresponding firm-level data in the \textit{EAE} survey.

\textsuperscript{17}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
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 versus non-exporters in France and 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 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.

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.

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 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. 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.

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. Figure 2 replicates the same exercise but only for TFP distributions, and it discriminates between exporters and non-exporters.

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). Figure 1 also shows that Japanese manufacturing firms (slightly) outperform their French counterparts in terms of TFP.\footnote{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 Mxelc 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 Mxelc 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. Finally, Figure 2 reveals that at the entire manufacturing level, the productivity gap...}
of exporters is larger than the productivity gap of non-exporters. 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

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 5 per cent while the average TFP advantage of Japanese firms computed for all manufacturing firms is only 2 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

To summarise, the striking evidence is that the productivity gap among Japanese and French exporters is larger than the average industry gap in the industries in which the
Japanese firms have a productivity advantage and smaller than the average industry gap 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.

An alternative explanation is that French and Japanese firms face very different trade-offs when deciding whether or not to expand their activities abroad. 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 indeed face very different trade costs.

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. 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.

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 and $\theta = \ln TFP$. If firm productivity is distributed normally in both countries, one can write $P = \mu_1 - \mu_2$, where $\mu_e$ 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:

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

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:

$$P_X = E(\theta_1|\theta_{1,i} > \theta_{c_{X,1}}) - E(\theta_2|\theta_{2,i} > \theta_{c_{X,2}})$$

$$= (\mu_1 - \mu_2) + \sigma \phi(z) \left[ \frac{1}{1 - \Phi(z_1)} - \frac{1}{1 - \Phi(z_2)} \right],$$

where $\gamma = \sigma_2/\sigma_1$ represents the standard deviation of the productivity distribution of country 2 relative to country 1. Equation (10) 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 $(\phi(z_1)/(1 - \Phi(z_1)) - \gamma(\phi(z_2)/(1 - \Phi(z_2))) > 0$, (resp., < 0). Assuming $\gamma = 1$, one can show that $\phi(z)/(1 - \Phi(z))$ is a monotonic transformation of $z$, so that the following holds:

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

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 $z_1 > z_2$. 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.

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20 For the proof, see Appendix C.

21 The condition holds as long as the relative standard deviation $\gamma$ exceeds $\phi(z_1)/(1 - \Phi(z_1))$/$\phi(z_2)/(1 - \Phi(z_2))$. 

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15
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 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 this mechanism 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 that 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.

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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References


### 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.²²

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.

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²²The 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).
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):

\[ K_{it} = K_{it-1}(1 - \delta_{t-1}) + I_{it}/p_{it}, \]  

(A-1)

where \( K_{it} \) is the capital stock for firm \( i \) operating in year \( t \); \( \delta_{t-1} \) is the depreciation rate in year \( t \); \( I_{it} \) is the investment of firm \( i \) in year \( t \); and \( p_{it} \) is the investment goods deflator for industry \( k \). 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 the notation):

\[ P_{Kt} = P_{lt-1}\tilde{P}_{Kt} + \delta_t\tilde{P}_{lt} - [P_{lt} - P_{lt-1}]. \]  

(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.

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21The concordance between the industry-level EU-KLEMS database and the firm-level EAE database is performed through the ISIC codes. The concordance tables are available upon request.

22Investment 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.

23If firm \( i \)'s investment was missing in year \( t \), we consider firm \( i \) as having made no investment: \( I_{it} = 0 \).

24Ideally, 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
Some discussions on the comparability of the data

Industry classification

To build a common industry classification between the French and Japanese data sets, we had to overcome two difficulties. 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. These concordance tables are available upon request. They are all reported in the working paper version of our paper (Bellone, Kiyota, Matsuura, Musso, and Nesta, 2013).

Definition of the primary firm-level variables

To establish firm-level nominal input and output series, we made 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 $Y^c_{it}$ as the nominal sales divided by the industry gross output price deflator $p^c_t$. The inputs consist of labour, capital, and intermediate inputs. Labour $L^c_{it}$ is obtained by multiplying the number of employees in the firm by the average hours worked by industry. The real capital stock $K^c_{it}$ is computed from tangible assets and investments based on the perpetual inventory method. The intermediate inputs $M^c_{it}$ are real intermediate inputs and are defined as nominal intermediate inputs deflated by the industry input price deflator $p^c_{Mt}$.

Firm-level data on exports are available 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.

Purchasing power parity (PPP)

To convert the input and output series in France and Japan into common units, we used 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.\footnote{See Inklaar and Timmer (2008) for a comprehensive description of the database and of the methodology followed to construct the PPP series.} 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.

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 $X^\varphi_{it}$ be input $K$, $L$, and $M$ or output $Y$ of any firm $i$ at time $t$, expressed in the local currency $\varphi$. Discarding the
subscripts $i$ and $t$ for simplicity of notation, the conversion into US$ PPP reads as follows:

$$X^\$ = \frac{X^\varphi}{PPP^X_{\varphi \rightarrow \$}}$$

(A-3)

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

$$X^{¥, FR} = \frac{X^{\varphi, FR} / PPP^X_{\varphi \rightarrow \$}}{PPP^X_{\$ \rightarrow ¥}} = X^{\varphi, FR} \times \frac{PPP^X_{¥ \rightarrow \$}}{PPP^X_{\varphi \rightarrow \$}},$$

(A-4)

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 $PPP^K_{\varphi \rightarrow \$}$, the purchasing power parity for capital $K$ between currency $\varphi$ and US dollars, we know that

$$PPP^K_{¥ \rightarrow \$} = PPP^K_{\varphi \rightarrow \$} \times \frac{p^K_{FR} / p^K_{US}}{p^K_{US} / p^K_{FR}},$$

(A-5)

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

$$PPP^I_{¥ \rightarrow \$} = PPP^I_{\varphi \rightarrow \$} \times \frac{p^K_{US}}{p^K_{FR}},$$

(A-6)

Based on all of the above, the conversion of the investment series $I^\varphi$ into $I^¥$ is

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

(A-7)

where $p^K_{JP}$ represents the user cost of capital in Japan. Based on this new series of invest-
ments, 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.

**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:

$$RCA_{c,k} = \frac{E_{c,k}}{E_c} \cdot \frac{E_{c,k}}{E_{c}}$$

(B-1)

where $E_{c,k}$ and $E_{c,k}$ are exports from industry $k$ by country $c$ and the world, respectively; $E_c$ and $E_c$ 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 B-1, 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 B-1, we indicate whether or not the comparative advantages/disadvantages of Japan over France are consistent with our productivity gap estimates.

Basically, Table B-1 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 inter-
Table B-1: Revealed Comparative Advantage (RCA) for France and Japan, 2006

<table>
<thead>
<tr>
<th>Industry</th>
<th>RCA</th>
<th>Consistent with TFP gaps</th>
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<tr>
<td></td>
<td>JP</td>
<td>FR</td>
</tr>
<tr>
<td>Textiles</td>
<td>0.768</td>
<td>0.508</td>
</tr>
<tr>
<td>Clothing</td>
<td>0.784</td>
<td>0.049</td>
</tr>
<tr>
<td>Manufacture of wood</td>
<td>0.663</td>
<td>0.014</td>
</tr>
<tr>
<td>Pulp and paper</td>
<td>1.202</td>
<td>0.270</td>
</tr>
<tr>
<td>Printing and publishing</td>
<td>1.162</td>
<td>0.302</td>
</tr>
<tr>
<td>Chemical products</td>
<td>1.524</td>
<td>0.936</td>
</tr>
<tr>
<td>Rubber and plastic</td>
<td>1.263</td>
<td>1.235</td>
</tr>
<tr>
<td>Non-metallic mineral products</td>
<td>1.209</td>
<td>1.028</td>
</tr>
<tr>
<td>Basic metal products</td>
<td>0.909</td>
<td>1.069</td>
</tr>
<tr>
<td>Fabricated metal products</td>
<td>1.070</td>
<td>0.657</td>
</tr>
<tr>
<td>Machinery and equipment</td>
<td>1.302</td>
<td>1.941</td>
</tr>
<tr>
<td>Machinery for office and services</td>
<td>1.057</td>
<td>1.987</td>
</tr>
<tr>
<td>Electric machinery and apparatus</td>
<td>0.595</td>
<td>1.352</td>
</tr>
<tr>
<td>Communication equipment and related products</td>
<td>0.678</td>
<td>0.792</td>
</tr>
<tr>
<td>Medical, precision and optical instruments</td>
<td>1.057</td>
<td>1.776</td>
</tr>
<tr>
<td>Motor vehicles</td>
<td>1.479</td>
<td>2.435</td>
</tr>
<tr>
<td>Other transportation equipment</td>
<td>2.652</td>
<td>1.333</td>
</tr>
<tr>
<td>Furniture and other manufacturing</td>
<td>0.670</td>
<td>0.412</td>
</tr>
</tbody>
</table>

Note: For the definition of RCA, see the main text. Source: Authors’ own calculations from the export data obtained from the UN Comtrade database.
national 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: 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 $z = \frac{\theta_{cX} - \mu}{\sigma}$ 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 $\theta_{cX}$ yields the following:

$$\frac{d\Gamma(z)}{dz} = \frac{\phi'(z)[1 - \Phi(z)] + \phi(z)^2}{[1 - \Phi(z)]^2}. \quad (C-1)$$

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 C-2 depends on the left hand expression of the numerator. Because $\Phi$ is the Normal cdf, we know that $\Phi \in [0, 1]$, which implies that $1 - \Phi$ is always positive. Likewise, $\phi$, 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,

$$\frac{d\Gamma(z)}{dz} = -\frac{z\phi(z)[1 - \Phi(z)] + \phi(z)^2}{[1 - \Phi(z)]^2}. \quad (C-2)$$

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

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

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

3. $\theta_{cX} > \mu$. 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 $\phi$ and $\Phi$ 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 \( d\Phi(z)/dz > d\phi(z)/dz \) \( \forall z \in \mathbb{R}^+ \).

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

Therefore \( z\phi(z)[1 - \phi(z)] > 0 \).

The above implies that the numerator \( \phi'(z)[1 - \phi(z)] + \phi(z)^2 \) is always positive. Therefore, \( \frac{\phi(z_1)}{1 - \Phi(z_1)} > \frac{\phi(z_2)}{1 - \Phi(z_2)} \) \( \forall z_1 > z_2 \). □
Table 1: Japan-France Productivity Gaps, Firm-level Databases, 2006

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

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

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

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

<table>
<thead>
<tr>
<th>Industry</th>
<th>JP N</th>
<th>FR N</th>
<th>Export participation</th>
<th>Export intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per cent</td>
<td>Per cent</td>
<td>Mean</td>
<td>Mean</td>
</tr>
<tr>
<td>All Manufacturing</td>
<td>100744</td>
<td>102004</td>
<td>27.5</td>
<td>84.6</td>
</tr>
<tr>
<td>Textiles</td>
<td>3148</td>
<td>5810</td>
<td>13.1</td>
<td>85.6</td>
</tr>
<tr>
<td>Clothing</td>
<td>6743</td>
<td>6743</td>
<td>6.9</td>
<td>72.9</td>
</tr>
<tr>
<td>Manufacture of wood</td>
<td>1345</td>
<td>2557</td>
<td>5.7</td>
<td>71.1</td>
</tr>
<tr>
<td>Pulp and paper</td>
<td>3728</td>
<td>3977</td>
<td>7.3</td>
<td>89.1</td>
</tr>
<tr>
<td>Printing and publishing</td>
<td>6948</td>
<td>6604</td>
<td>6.4</td>
<td>71.4</td>
</tr>
<tr>
<td>Chemical products</td>
<td>8576</td>
<td>8904</td>
<td>45.0</td>
<td>94.0</td>
</tr>
<tr>
<td>Rubber and plastic</td>
<td>6339</td>
<td>8538</td>
<td>22.9</td>
<td>83.9</td>
</tr>
<tr>
<td>Non-metallic mineral products</td>
<td>5127</td>
<td>4565</td>
<td>18.5</td>
<td>75.5</td>
</tr>
<tr>
<td>Basic metal products</td>
<td>6721</td>
<td>3652</td>
<td>23.6</td>
<td>92.5</td>
</tr>
<tr>
<td>Fabricated metal products</td>
<td>8786</td>
<td>13083</td>
<td>18.8</td>
<td>84.2</td>
</tr>
<tr>
<td>Machinery and equipment</td>
<td>12349</td>
<td>13260</td>
<td>44.8</td>
<td>86.9</td>
</tr>
<tr>
<td>Machinery for office and services</td>
<td>1430</td>
<td>423</td>
<td>34.9</td>
<td>97.3</td>
</tr>
<tr>
<td>Electric machinery and apparatus</td>
<td>12186</td>
<td>6696</td>
<td>34.8</td>
<td>85.8</td>
</tr>
<tr>
<td>Communication equipment and products</td>
<td>2148</td>
<td>1394</td>
<td>31.1</td>
<td>73.2</td>
</tr>
<tr>
<td>Medical precision and optical instruments</td>
<td>4716</td>
<td>4522</td>
<td>51.8</td>
<td>92.2</td>
</tr>
<tr>
<td>Motor vehicles</td>
<td>8217</td>
<td>3483</td>
<td>24.8</td>
<td>90.5</td>
</tr>
<tr>
<td>Other transportation equipment</td>
<td>1979</td>
<td>2087</td>
<td>31.7</td>
<td>87.3</td>
</tr>
<tr>
<td>Furniture and other manufacturing</td>
<td>3712</td>
<td>5706</td>
<td>27.8</td>
<td>92.3</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Size class</th>
<th>France</th>
<th></th>
<th>Japan</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Export premium</td>
<td>N</td>
<td>Export premium</td>
</tr>
<tr>
<td>All manufacturing firms</td>
<td>99,963</td>
<td>0.0138 (p value)</td>
<td>100,744</td>
<td>0.056 (p value)</td>
</tr>
<tr>
<td>SMEs (50–249)</td>
<td>75,850</td>
<td>0.0103 (p value)</td>
<td>71,452</td>
<td>0.038 (p value)</td>
</tr>
<tr>
<td>Intermediate (250–499)</td>
<td>13,232</td>
<td>-0.0003 (p value)</td>
<td>14,919</td>
<td>0.031 (p value)</td>
</tr>
<tr>
<td>Large (+500)</td>
<td>10,881</td>
<td>0.0050 (p value)</td>
<td>14,373</td>
<td>0.026 (p value)</td>
</tr>
</tbody>
</table>

Note: $\beta$ 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

<table>
<thead>
<tr>
<th>Industry</th>
<th>JP mean difference</th>
<th>FR mean difference</th>
<th>TFP mean difference</th>
<th>JP mean difference</th>
<th>FR mean difference</th>
<th>TFP mean difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Manufacturing</td>
<td>1.04</td>
<td>1.02</td>
<td>0.02***</td>
<td>1.07</td>
<td>1.02</td>
<td>0.05***</td>
</tr>
<tr>
<td>Textiles</td>
<td>1.31</td>
<td>0.59</td>
<td>0.72***</td>
<td>1.37</td>
<td>0.59</td>
<td>0.78***</td>
</tr>
<tr>
<td>Clothing</td>
<td>1.23</td>
<td>0.61</td>
<td>0.62***</td>
<td>1.34</td>
<td>0.61</td>
<td>0.73***</td>
</tr>
<tr>
<td>Manufacture of wood</td>
<td>0.78</td>
<td>1.19</td>
<td>−0.41***</td>
<td>0.80</td>
<td>1.18</td>
<td>−0.38***</td>
</tr>
<tr>
<td>Pulp and paper</td>
<td>1.08</td>
<td>0.90</td>
<td>0.18***</td>
<td>1.11</td>
<td>0.89</td>
<td>0.22***</td>
</tr>
<tr>
<td>Printing and publishing</td>
<td>0.96</td>
<td>1.00</td>
<td>−0.04***</td>
<td>1.01</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Chemical products</td>
<td>0.90</td>
<td>1.19</td>
<td>−0.29***</td>
<td>0.93</td>
<td>1.19</td>
<td>−0.27***</td>
</tr>
<tr>
<td>Rubber and plastic</td>
<td>0.49</td>
<td>1.58</td>
<td>−1.09***</td>
<td>0.52</td>
<td>1.58</td>
<td>−1.06***</td>
</tr>
<tr>
<td>Non-metallic mineral products</td>
<td>0.72</td>
<td>1.27</td>
<td>−0.55***</td>
<td>0.76</td>
<td>1.27</td>
<td>−0.51***</td>
</tr>
<tr>
<td>Basic metal products</td>
<td>1.02</td>
<td>0.94</td>
<td>0.08***</td>
<td>1.05</td>
<td>0.94</td>
<td>0.10***</td>
</tr>
<tr>
<td>Fabricated metal products</td>
<td>0.95</td>
<td>1.04</td>
<td>−0.09***</td>
<td>0.97</td>
<td>1.04</td>
<td>−0.07***</td>
</tr>
<tr>
<td>Machinery and equipment</td>
<td>1.00</td>
<td>1.04</td>
<td>−0.04***</td>
<td>1.02</td>
<td>1.04</td>
<td>−0.01***</td>
</tr>
<tr>
<td>Machinery for office and services</td>
<td>1.38</td>
<td>0.88</td>
<td>0.51***</td>
<td>1.45</td>
<td>0.88</td>
<td>0.57***</td>
</tr>
<tr>
<td>Electric machinery and apparatus</td>
<td>1.27</td>
<td>0.94</td>
<td>0.33***</td>
<td>1.31</td>
<td>0.94</td>
<td>0.37***</td>
</tr>
<tr>
<td>Communication equipment and related products</td>
<td>1.28</td>
<td>1.17</td>
<td>0.12***</td>
<td>1.34</td>
<td>1.17</td>
<td>0.17***</td>
</tr>
<tr>
<td>Medical precision and optical instruments</td>
<td>1.26</td>
<td>0.93</td>
<td>0.33***</td>
<td>1.28</td>
<td>0.93</td>
<td>0.35***</td>
</tr>
<tr>
<td>Motor vehicles</td>
<td>1.32</td>
<td>0.68</td>
<td>0.64***</td>
<td>1.35</td>
<td>0.68</td>
<td>0.67***</td>
</tr>
<tr>
<td>Other transportation equipment</td>
<td>1.23</td>
<td>0.68</td>
<td>0.55***</td>
<td>1.28</td>
<td>0.69</td>
<td>0.59***</td>
</tr>
<tr>
<td>Furniture and other manufacturing</td>
<td>0.89</td>
<td>1.17</td>
<td>−0.27***</td>
<td>0.95</td>
<td>1.17</td>
<td>−0.22***</td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th>All Manufacturing</th>
<th>All firms Critical Distance</th>
<th>Exporters Critical Distance</th>
<th>Non-exporters Critical Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Distance</td>
<td>Critical</td>
<td>Distance</td>
</tr>
<tr>
<td>All Manufacturing</td>
<td>-0.081</td>
<td>0.000</td>
<td>-0.199</td>
</tr>
<tr>
<td>Textiles</td>
<td>-0.981</td>
<td>0.000</td>
<td>-1.000</td>
</tr>
<tr>
<td>Clothing</td>
<td>-0.922</td>
<td>0.000</td>
<td>-0.989</td>
</tr>
<tr>
<td>Manufacture of wood</td>
<td>0.975</td>
<td>0.000</td>
<td>0.989</td>
</tr>
<tr>
<td>Pulp and paper</td>
<td>-0.715</td>
<td>0.000</td>
<td>-0.788</td>
</tr>
<tr>
<td>Printing and publishing</td>
<td>0.077</td>
<td>0.000</td>
<td>-0.105</td>
</tr>
<tr>
<td>Chemical products</td>
<td>0.749</td>
<td>0.000</td>
<td>0.727</td>
</tr>
<tr>
<td>Rubber and plastic</td>
<td>0.999</td>
<td>0.000</td>
<td>0.999</td>
</tr>
<tr>
<td>Non-metallic mineral products</td>
<td>0.963</td>
<td>0.000</td>
<td>0.938</td>
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<tr>
<td>Basic metal products</td>
<td>-0.347</td>
<td>0.000</td>
<td>-0.436</td>
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<tr>
<td>Fabricated metal products</td>
<td>0.309</td>
<td>0.000</td>
<td>0.239</td>
</tr>
<tr>
<td>Machinery and equipment</td>
<td>0.137</td>
<td>0.000</td>
<td>0.067</td>
</tr>
<tr>
<td>Machinery for office and services</td>
<td>-0.874</td>
<td>0.000</td>
<td>-0.935</td>
</tr>
<tr>
<td>Electric machinery and apparatus</td>
<td>-0.669</td>
<td>0.000</td>
<td>-0.740</td>
</tr>
<tr>
<td>Communication equipment and related products</td>
<td>-0.369</td>
<td>0.000</td>
<td>-0.481</td>
</tr>
<tr>
<td>Medical precision and optical instruments</td>
<td>-0.703</td>
<td>0.000</td>
<td>-0.742</td>
</tr>
<tr>
<td>Motor vehicles</td>
<td>-0.986</td>
<td>0.000</td>
<td>-0.996</td>
</tr>
<tr>
<td>Other transportation equipment</td>
<td>-0.931</td>
<td>0.000</td>
<td>-0.968</td>
</tr>
<tr>
<td>Furniture and other manufacturing</td>
<td>0.718</td>
<td>0.000</td>
<td>0.639</td>
</tr>
</tbody>
</table>

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.
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
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