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

Flora Bellone, Kyota Kyoiko, Toshiyuki Matsuura, Patrick Musso, Lionel Nesta

International productivity gaps and the export status of firms: Evidence from France and Japan

Flora Bellone , Kozo Kiyota, Toshiyuki Matsuura, Patrick Musso , Lionel Nesta

A B S T R A C T

This paper provides new evidence on international productivity gaps; this evidence is obtained from large-scale firm-level data from the French and Japanese manufacturing industries using non-parametric methodologies designed to overcome confidentiality restrictions. Our primary finding is that international productivity gaps are sensitive to the export status of firms. We also show that productivity differences between French and Japanese exporters vary across export destinations. We propose a simple analytical framework to relate those basic findings to the new models of international trade with heterogeneous firms. Under this framework, interna-tional firm-level productivity comparisons provide new insights into the importance of trade-related institutional and policy differences across countries.

1. Introduction

Are firms from different countries that compete in international markets closer in terms of efficient productivity than purely domestic firms? This question is non-trivial. On the one hand, if the productivity gap is closer between exporters from two different countries than between domestic firms, it is important to enhance the productivity of domestic firms to fill the international productivity gap. On the other hand, if there are any systematic patterns in the productivity gap between exporters from different countries, we can relate international productivity gaps to international factors such as trade costs, implying that a reduction of trade costs is necessary to fill the international productivity gaps.[1] Such differences

---

Abbreviation: BSJBSA, basic survey of Japanese business structure and activities; EAE, Enquête Annuelle d'Entreprises; FJ, France–Japan; FTA, free trade agreement; GGDC, Groningen Growth Development Centre; GNS, good Nadiri and Sickles; INSEE, French National Statistical Office; ISGEP, International Study Group on Exports and Productivity; KS, Kolmogorov–Smirnoff; METI, Ministry of Economy Trade and Industry; RIETI, Research Institute for Economy Trade and Industry; SESSI, Research and Statistical Department of the French Ministry of Industry

* Corresponding author. Tel.: +33 4 93 95 43 51.

[1] In this paper, trade costs will reflect not only transportation costs, but also trade policy such as tariff and non-tariff barriers.

have different policy implications. While a number of studies attempted to relate international productivity gaps to innovation activities such as research and development (R&D), until now, the relationship between international productivity gaps and international activities has been overlooked, at least for developed countries. This paper contributes to filling this gap by proposing a first investigation of the relationship between international productivity gaps and firm export status across two industrialised countries, namely France and Japan.

Investigating productivity differences across firms over different countries is not a straightforward exercise. On the empirical side, it 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 using firm-level data very scarce in the literature.[2] 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 present a framework of analysis in which in the presence of firm heterogeneity and differentiated trade costs across countries, firm selection partly determines international productivity gaps. Second, we propose an empirical strategy that allows the comparison of reliable firm-level total factor productivity (TFP) indices from large-scale firm-level datasets (for which confidentiality restrictions apply). Finally, we reveal that a systematic pattern does indeed exist that relates the productivity gaps between French and Japanese firms to their export status. Specifically, 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 with France. Building on this basic finding, we show how productivity comparisons across exporting and non-exporting firms from different countries can be used as a further test of relevance for the recent models of international trade and heterogeneous firms. In turn, we also show how international firm-level productivity comparisons can be used to provide useful insights into important trade-related institutional and policy differences across countries, using a comparison between France and Japan as a case study.

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 datasets. 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.[3] 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.[4] Only a few of the previous studies have provided comparisons of the entire distributions of firm productivity.[5] Finally, some of the previous studies relied on private data sources that are rich, but limited in scope. For instance, using the McKinsey Global Institute firm-level database, Baily and Solow (2001) computed several industry productivity gaps across the United States, Germany, Japan, and France, but only for a limited number of industries.[6]

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.[7] However, the previous studies on firm heterogeneity and exports lack the perspective offered by an international comparison. An exception is a study by ISGEP (International Study Group on Exports and Productivity) (2008), which analysed the export premia of 14 countries.[8] This study compared the export premia across countries, but not the firm-level productivity. 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 yet. In this paper, we propose to fill this gap by investigating how international productivity gaps relate to firms'

---

[2] Most of the recent literature investigating international productivity gaps from a firm-level perspective addresses allocative efficiency issues but do not compare directly firm performances across countries (see Bartelsman et al., 2013 for one of the most recent contributions in this field.)

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

[4] Fukao et al. (2008a) compared the productivity of listed firms in China, Japan, and South Korea. Fukao et al. (2008) extended the analysis, adding Taiwanese listed firms. Lee and Fukao (2008) and Jung and Lee (2010) compared the productivity of listed firms in Japan and Korea. All of these studies have focused on the difference in the average productivity gap.

[5] Most notably, Aw et al. (2000) compared large-scale Korean and Taiwanese plant-level data, but the period is different between the two datasets. Ahn et al. (2004) used Korean plant-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.

[6] 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).

[7] Greenaway and Kneller (2007), Wagner (2007, 2012), and Hayakawa et al. (2012) provide excellent literature reviews on firm heterogeneity and export behaviours.

[8] The ISGEP study included France, but not Japan.

export status, using balance sheet information and the export status of all 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 provide a framework of analysis derived from the recent models of international trade with heterogeneous firms which allows to link international productivity gaps to firms' export status. In the second 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. To build our empirical strategy, we rely on the Good et al. (1997) (GNS) productivity index method that we extend to overcome the specific issues of confidentiality restrictions. We also 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 datasets into a unique set.[9]

This paper uses firm-level datasets in France and Japan because these data have the following advantages. First, the French and Japanese firm-level data are highly comparable with one another, which is a necessary prerequisite for estimating productivity level differences. This high degree of comparability allows us to construct two separate unbalanced panel datasets with the same coverage: the same period, the same industries, the same employment threshold, and the same definition of inputs and output. 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. Finally, France and Japan can also be expected to exhibit substantial relative trade cost differences. French firms take advantage of being a member of the European Union by which they can export at low cost. Japanese firms instead must incur significant export costs because Japan still has free trade agreements (FTAs) with only a limited number of countries.[10]

The rest of the paper is structured as follows. Section 2 develops a simple analytical framework from which we derive testable propositions about the relationship between international productivity gaps and the firm export status that we then use as guidelines for our empirical investigation. In Section 3, we present our empirical strategy for providing productivity comparisons built from separated firm-level data originated from different countries. Section 4 explains the data. Section 5 presents our estimates of the average productivity gaps between France and Japan and shows they are consistent 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 6, which establishes empirically the relationship between international productivity gaps and the export status of firms and then shows how this finding connects with our analysis framework. A summary of our findings and implications is presented in the final section.

2. An analysis framework

In this section, we derive simple testable propositions about the relationship between international productivity gaps and the export status of firms. Starting from the pioneering models of Bernard et al. (2003) and Melitz (2003), a large class of models in this literature predict that exporters should be more productive than non-exporters in any given country. This simple prediction does not require that learning-by-exporting occurs, but only that the costs of operating in domestic markets are lower than the costs of operating in foreign markets. Indeed, in the presence of trade costs and ex ante firm heterogeneity within industries, only the most productive firms within each single industry will self-select into exporting. Obviously, if learning-by-exporting also prevails, as in the earlier model by Clerides et al. (1998), the productivity gap between exporters and non-exporters can be even larger.[11]

The literature on firm heterogeneity and international trade has not only implications for the difference of productivity between exporters and non-exporters in a given country, but also implications for international productivity gaps. In this section, we formally explore some of these implications within a simple framework of two small open economies trading with the rest of the world. These two small open economies are indexed as Country 1 and Country 2, respectively, and differ both in terms of their underlying technology and trade costs.

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 log 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 $c (\in \{1, 2\})$. 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.

For the sake of simplicity, we assume that firm productivity is distributed log normally in both countries 1 and 2.[12] Let us denote $G_1(z_1)$ and $G_2(z_2)$ as the firm productivity distributions for Country 1 and Country 2, respectively, where $z_c = (\theta_{c_X,c} - \mu_c)/\sigma_c$ and σ_c is the second moment of the normal distribution for country c. We assume that $G_1(z_1)$ and $G_2(z_2)$ are such that Country 1 benefits from an average productivity advantage over Country 2 as illustrated in Fig. 1. We 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.

Under perfect sorting, all of the firms exceeding the country-specific threshold values $\theta_{c_X,c}$ manage to export, whereas firms failing to reach the threshold focus on the domestic market. This result implies that the mean of the exporters in a given country is as follows:

$$E(\theta_c | \theta_{c,i} > \theta_{c_X,c}) = \mu_c + \sigma_c \frac{\phi(z_c)}{1 - \Phi(z_c)}, \tag{1}$$

where $\phi(\cdot)$ and $\Phi(\cdot)$ are the probability density function and the cumulative distribution function, respectively, of the standard normal; $\theta_{c,i}$ is the productivity of firm i in country c. 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, $(1 - \Phi(z_c))$ 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, is as follows:

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

where $\gamma = \sigma_2 / \sigma_1$ represents the standard deviation of the productivity distribution of Country 2 relative to Country 1. Eq. (2) says that the productivity gap between exporters from two countries is 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

$$\left(\frac{\phi(z_1)}{1 - \Phi(z_1)} - \gamma \frac{\phi(z_2)}{1 - \Phi(z_2)} \right) > 0 \text{ (resp., } < 0).$$

Assuming $\gamma = 1$, one can show that $\phi(z)/(1 - \Phi(z))$ is a monotonic transformation of z, so that the following holds:[13]

$$\frac{\phi(z_1)}{1 - \Phi(z_1)} > \frac{\phi(z_2)}{1 - \Phi(z_2)} > 0 \quad \text{if } z_1 > z_2. \tag{3}$$

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 $z_1 > z_2$.[14] 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.

Fig. 1 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. Fig. 1 also shows the mean productivity 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 than in Country 2. Note that this mechanism can 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 $P_X < P$.

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 and Bernard et al. (2003)-type models. The mechanism is particularly consistent with the models that explicitly feature country-specific trade costs such as Helpman et al. (2008) or the models that feature firm heterogeneity, comparative advantage, and country-specific trade costs such as the Bernard et al. (2007) model.

---

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

[13] For the proof, see Appendix A.

[14] The condition holds as long as the relative standard deviation γ lowers $\phi(z_1)/(1 - \Phi(z_1))/\phi(z_2)/(1 - \Phi(z_2))$.
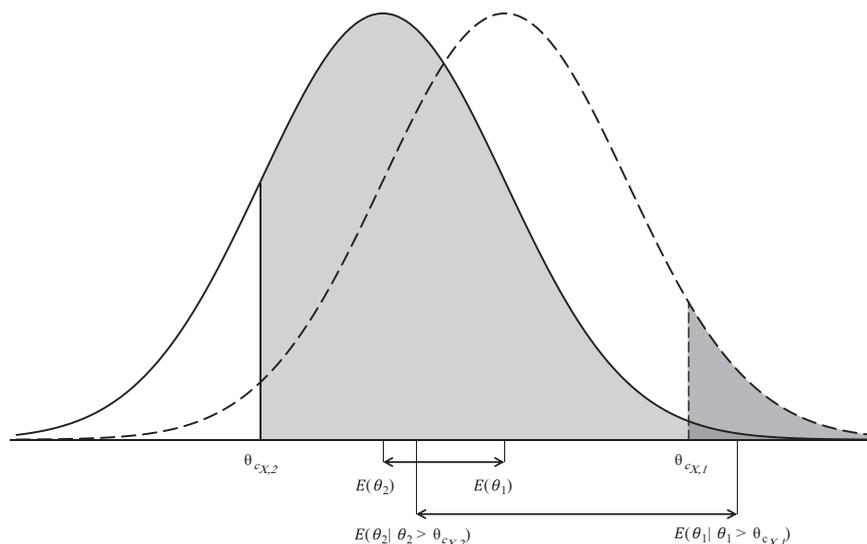
Fig. 1. Productivity gaps as a function of export threshold value, dashed line = Country 1, solid line=Country 2.

Note that our approach focuses on the self-selection of more-productive firms into exporting. However, learning-by-exporting may also be an important mechanism in some countries, especially in developing countries. The implications we derived about the relationship between relative productivity and relative trade costs across countries should be interpreted as a first approximation to countries where self-selection is a main source of the export premium.

3. Empirical methodology

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

3.1. 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.[15] 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 datasets.

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 a non-parametric methodology based on the multilateral index number approach developed by GNS.[16] Our detailed methodology is presented in Appendix B.

For the purpose of international comparison, the productivity index method has several advantages. First, it allows for separate (but comparable) measures of individual TFP across countries without requiring that the firms share the same production technology.[17] Second, as emphasised by Bartelsman et al. (2013), by taking the difference between the output (inputs) of each firm and that of a hypothetical reference firm in a given country, firm- and country-specific factors are "differenced" out. Finally, a last 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, mainly at a detailed industry level, based on the recently compiled EU-KLEMS database (for a

---

[15] Non-confidential micro-level databases from private sources exist. 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 datasets are usually less comprehensive than the firm-level statistics collected by the national offices.

[16] A number of studies on firm export heterogeneity employ the multilateral index number approach. See Aw et al. (2001, 2003), Girma et al. (2005), and Kimura and Kiyota (2006), for example.

[17] On the flip side, this non-parametric method is sensitive to measurement error (for more detail on the relative advantage of non-parametric and semi-parametric methodologies, see 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 error than the data from private sources. In that respect, the use of the index method may be more appropriate in our research than in the research that relies on private firm-level data sources.

description of the dataset, see O'Mahony and Timmer (2009). Implementing a similar methodology to the GGDC allows 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.

3.2. Testing procedure under confidentiality restrictions

Once we have computed the individual relative productivity indices, we investigate the industry productivity gaps between France and Japan by two means. First, we use the standard Student's t-test of equality of the TFP means between the French and Japanese firms operating in the same industry.[18]

Second, we use the testing procedure proposed by Delgado et al. (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. Our methodology of performing the KS tests of stochastic dominance under confidentiality restrictions is detailed in Appendix C.

One final concern is that the firms faced various industry-country-specific shocks such as the business cycle and 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:

$$\widetilde{\theta_{it}^{c,k}} = \theta_{it}^{c,k} - \overline{\theta_t^{c,k}} + \overline{\theta^{c,k}}, \tag{4}$$

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 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 dataset, both at the overall manufacturing level and at the two-digit industry level. We also present the results of those tests performed separately on the subsets of the exporting and non-exporting firms.

4. Data

Both the French and the Japanese firm-level data used in this study were collected by national statistical offices. Data for France were drawn from the confidential Enquête Annuelle d'Enterprises (*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 were drawn from the confidential micro-level database of the *Kigyou Katsudou Kihon Chousa Houkokusho* (*Basic Survey of Japanese Business Structure and Activities*: *BSJBSA*) prepared annually by the Research and Statistics Department, METI (1994–2006). This survey was first conducted in 1991 and then annually from 1994. The main purpose of the survey is to capture statistically the overall picture of Japanese corporate firms in light of their activities in diversification, globalisation, and strategies for R&D 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 (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.[19] Other limitations are that information on export destination is available at the region level, but not at the country level (e.g., Asia, Europe, and North America) in Japan, while that of foreign direct investment is not available for France.

One crucial requirement for our study is that the firm-level variables for 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,[20]

---

[18] One may argue that we should conduct different non-parametric tests such as the Wilcoxon rank-sum test and the Mann–Whitney U test to check the equality. Note, however, that it is impossible to merge firm-level datasets 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 log normally distributed; this drawback is an issue because, as has been emphasised in the literature, firm-level TFP is usually not log normally distributed in reality. Indeed, the null hypothesis that the distribution of firm-level TFP is log normal is rejected in 17 out of 18 industries both in France and Japan.

[19] In 2002, the *BSJBSA* covered approximately one-third of Japan's total labour force, excluding the public, financial, and other service industries that are not covered in the survey (Kiyota et al., 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 et al., 2008a) excluding the *Food, Beverages, and Tobacco* industry, which is not covered in the survey.

[20] Because of the high comparability of the firm-level data in Japan and France, a recent international comparative study by Dobbelaere et al. (2012) also used the *EAE* and the *BSJBSA* data.

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 are fully described in Appendix D.

The data-implementation step allows us to construct two separate unbalanced panel datasets with the same coverage: the same period (1994–2006), the same industries, the same employment threshold (over 50 employees), and the same definition of inputs and output, to estimate the TFP index. In our framework, the TFP index (Eq. (B.2)) can be estimated without merging national firm-level datasets. Only the characteristics of the French representative firms (one for each industry) must be shared across countries.

One may be concerned that ignoring firms with fewer than 50 employees creates some distortions for the productivity comparison between exporters and non-exporters. Although Japanese firm-level data are not available for firms with fewer than 50 employees, the exporter premium for firms with 50 employees can be compared with that for firms with 20 employees, using French firm-level data. We find that the difference in the exporter premium between the two datasets is rather small: just 0.8 percentage points for all manufacturing. The distortion does not seem to be severe.

5. Average industry productivity gaps from firm-level data

The most detailed productivity gap estimates that exist at the industry level are those recently compiled by GGDC from the industry-level EU-KLEMS data. According to the GGDC Productivity Levels Database, Inklaar and Timmer (2008) provide 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 with 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 with 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 mainly 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

Table 1
Japan–France productivity gaps, firm-level databases, 2006.
Source: Authors' own calculations.

Industry	JP			FR			JP/FR
	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 logarithms.

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.

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 fewer 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 (information and communication technology (ICT) capital and non-ICT capital). To check the consistency between our estimates and the GGDC estimates, we used concordance tables to aggregate our data into the industries in the EU-KLEMS database.[21] 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.[22]

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 eight of 11 industries, the relative rankings of France and Japan are consistent from one series to the other. Among them, Japan leads productivity in three industries (*Textiles*, *textile products*, *leather*, *and footwear*, *Transport equipment*, and *Electrical and optical equipment*), while France leads productivity 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 2 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 5 per cent more productive) according to the GGDC series, while Japan is slightly less productive than France (less than 5 per cent less productive) according to our own series. The largest 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. 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 provides us with some confidence in the robustness of our firm-level relative TFP indices. We are now ready to discuss the results from the estimates of the international productivity gap across different subsets of manufacturing firms within industries.

6. 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.

6.1. 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 export-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 in Table 3, 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.

Table 3 shows that both the export-participation rate and the export intensity are much higher in France in comparison with Japan. These patterns hold both for overall manufacturing and for each of our 18 industries. According to the information reported for overall manufacturing, 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.[23]

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.

---

[21] The concordance tables are available in Appendix A of the working paper version of our paper (Bellone et al., 2013).

[22] 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.

[23] One may be concerned by the lower export-participation rate in Japan. Previous studies reported that the export-participation rate varies even across developed countries: 59.3 per cent in Germany, 74.4 per cent in Italy, 28.3 per cent in the United Kingdom (Mayer and Ottaviano, 2008, and 21 per cent in the United States (Bernard et al., 2003). On average, European Union members tend to have higher export-participation rates than Japan and the U.S.

Table 2
France–Japan TFP comparisons: industry-level data versus firm-level data. Benchmark year 1997.
Source: Authors' own calculations.

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

Notes: "nec" means "not elsewhere classified." The GGDC series are sourced from http://www.ggdc.net/databases/levels.htm. "JP/FR Our team" series are based on our own (firm-level) TFP computations. Specifically, column 4 reports the ratio of the unweighted means of the Japanese and the French firms' TFP distributions computed for the benchmark year 1997, respectively. 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.
Source: Authors' own calculations.

Industry	JP N	FR N	Export participation		Export intensity	
			JP per cent	FR per cent	JP mean	FR mean
All manufacturing	100,744	102,004	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	13,083	18.8	84.2	5.9	18.5
Machinery and equipment	12,349	13,260	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	12,186	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

Export participation is the percentage of exporting firms over the period of observation. Export intensity is computed as the mean of the ratio of exports over sales for exporting firms only.

We perform this exercise first for the entire set of manufacturing firms and then for different firm-size groupings, distinguishing *small and medium enterprises* (SMEs) as firms of 50–249 employees, *intermediate firms* as firms of 250–500 employees, and *large firms* as firms of over 500 employees. The results are reported in Table 4 below.

Table 4 shows the existence of an export premium both in France and Japan. Moreover, the premium is higher in Japan than in France. It is approximately 5 per cent in Japan while it is only 1.4 per cent in France when estimated for the entire set of manufacturing firms. The break-down of the sample by size shows that in France, an export premium exists only within the group of SMEs. In contrast, 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 SMEs and intermediate and large firms in Japan. As expected, the export premium is higher within the group of SMEs than it is

Table 4
TFP export premium, by size class, 1994–2006.
Source: Authors' own calculations.

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

Notes: 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.
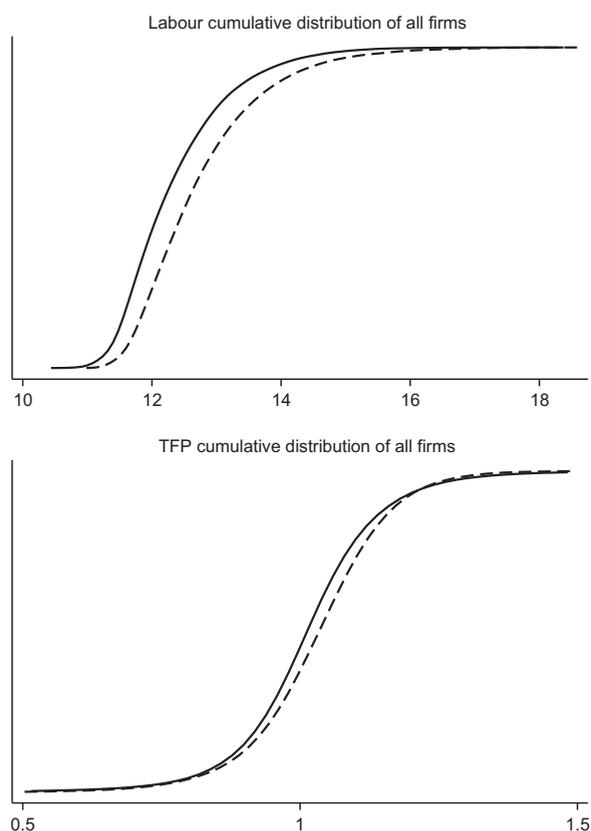

Fig. 2. Cumulative size and TFP distributions of manufacturing firms: France (solid line) and Japan (dashed line), 1994–2006.

within the group of large firms. However, the export premium for large firms in Japan is still 2.6 per cent. In the next subsection, we investigate this issue further.

6.2. 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 overall manufacturing level. We first graph those distributions for the full sample of manufacturing firms and then
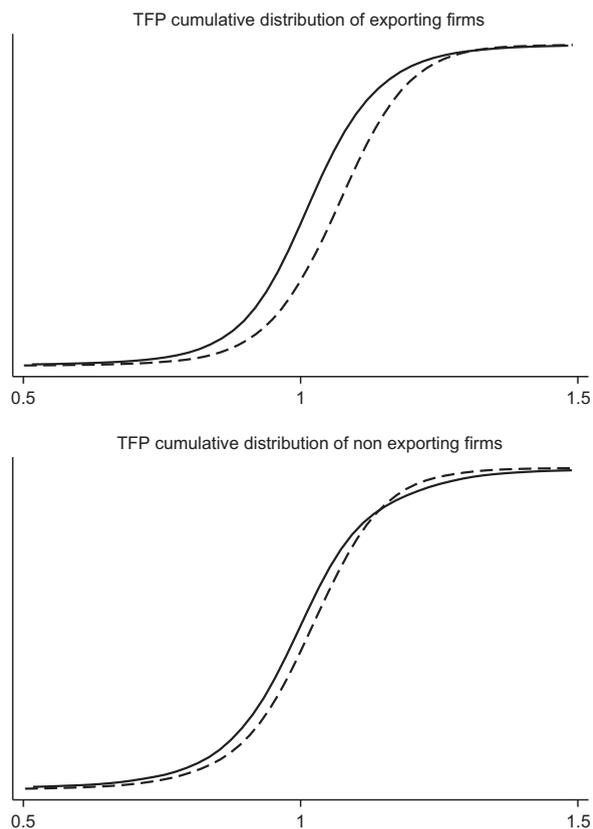
TFP cumulative distribution of exporting firms

TFP cumulative distribution of non exporting firms

Fig. 3. Cumulative TFP distributions of manufacturing firms by export status: France (solid line) and Japan (dashed line), 1994–2006.

separately for the subsamples of exporting and non-exporting firms. Specifically, Fig. 2 displays the size (measured as the number of employees) and TFP distributions for all manufacturing firms in France and Japan. Fig. 3 replicates the same exercise, but only for TFP distributions, and it discriminates between exporters and non-exporters.

Fig. 2 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). Fig. 2 also shows that Japanese manufacturing firms (slightly) outperform their French counterparts in terms of TFP.[24] Finally, Fig. 3 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.

The t-tests confirm the idea that the productivity gaps are larger across exporters than across non-exporters at the overall 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.

A similar pattern exists for individual industries: 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

---

[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 terms of manufacturing, excluding the electrical (*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.

Table 5
Productivity level differences between French and Japanese firms by industry and by export status.
Source: Authors' own calculations.

Industry	All firms			Exporters			Non-exporters		
	JP mean	FR mean	TFP difference	JP mean	FR mean	TFP difference	JP mean	FR mean	TFP difference
All manufacturing	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 logarithms) of Japanese and French firms. Positive values indicate that Japanese firms outperform their French counterparts.
 ** Indicate statistical significance at the 5 per cent level.
 *** Indicate statistical significance at the 1 per cent level.

France has the productivity lead (eight 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 with 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 with 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 is log 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 dataset, both at the entire manufacturing group level and at the two-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.

The most striking evidence that emerges from Table 6 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 technology. Indeed, if country-specific productivity advantages were the only force driving international productivity gaps, there should be no difference 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, the productivity gap across the exporters of two different countries should be systematically narrower than the productivity gaps across the non-exporters of the same two countries. Specifically, in the frame of our comparison, this pattern should hold in all industries, and not only in industries in which Japan has a productivity disadvantage.

The only way to reconcile our empirical finding with our analytical framework is to assume that Japan is characterised by higher trade costs compared with France. In such a case, Japanese firms have a higher cost cut-off than French firms, as illustrated in Fig. 1 with Country 1 portraying Japan and Country 2 portraying France. As a consequence of the stronger selection of Japanese firms into export markets, the productivity advantage of Japanese firms widens when comparing exporting firms exclusively. Conversely, in industries where French firms outperform their Japanese counterparts, the productivity advantage of exporters shrinks.

One may be concerned that our findings are attributable not to trade costs, but to the difference in destination markets between French and Japanese exporters. Because France and Japan are located in different regions, there may be differences

Table 6
Kolmogorov–Smirnov test for stochastic dominance of G(JP) over G(FR).
Source: Authors' own calculations.

	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
Productivity differences by export destination for all manufacturing firms.
Source: Authors' own calculations.

	JP mean	FR mean	TFP difference
All firms	1.038	1.022	0.016***
Exporters			
To North America	1.090	1.043	0.047***
To Europe	1.094	1.030	0.064***
To Asia	1.074	1.035	0.039***

Notes: Exporters in this table are restricted to those firms that export to specific destinations.
Asia includes Bangladesh, China, Hong Kong, India, Macao, Mongolia, Pakistan, South Korea, Taiwan, Sri Lanka, and ASEAN countries. Europe includes EU (28) countries, Iceland, Norway, Switzerland, Turkey, former Soviet Union countries, and former Yugoslavian countries. North America is composed of Canada and the United States.
    *** Indicates statistical significance at the 1 per cent level.

in destination markets explaining the observed pattern. To test for the robustness of our findings, we compare the relative productivity of French and Japanese exporters with three different regions of the world: Asia, Europe, and North America. Table 7 presents the results.

The differences in the average productivity of French and Japanese exporters vary substantially across the regions. The largest average gap (about 6.4 per cent) is between Japanese exporters to Europe and their French counterparts. This result is consistent with the idea that trading to Europe is less costly for French firms than it is for Japanese ones. Conversely, the lowest productivity gap (about 3.9 per cent) is between Japanese exporters to Asia and their French counterparts, which is consistent with the fact that the Asian markets are more accessible to Japanese exporters compared with the European markets. Finally, the productivity gap of Japanese exporters to North America compared with their French counterparts is in-between, suggesting that French firms may benefit from a cost advantage over their Japanese counterparts in reaching North American markets. Overall, the most interesting feature of Table 7 is that whatever the destination, the productivity gap between French and Japanese exporters remains larger than the average productivity gap. Under our framework, this feature supports the idea that the differences in transport costs are not the only driver of the productivity gaps between French and Japanese exporters.

All in all, our results suggest that France and Japan, despite being both similarly industrialised and liberalised countries, still exhibit substantially different degrees of trade barriers. This difference could be because of differences in trade-related institutions and non-tariff barriers rather than because of mere differences in trade tariffs or transport costs. For instance,

the Japanese Cabinet Secretariat (2010) documents that Japan's trade share with FTA partners is much lower than the European Union's trade share (16 per cent versus 76 per cent). Novy (2013) utilised a micro-founded gravity approach to indirectly infer barriers to international trade for 12 industrialised countries. His study found that the level of trade barriers differs substantially across similarly developed countries. Specifically, he estimates that trade barriers are significantly higher in Japan compared to France.

7. Concluding remarks

This paper provided new evidence on international productivity gaps. One of the contributions of this paper was to directly compare the distribution of firm-level TFP within the same industry across two different countries. Another contribution of this paper was to propose an empirical protocol that reconciles the need to establish international comparisons of firm-level analysis with data-confidentiality restrictions.

We first presented a simple framework of analysis to relate cross-country productivity gaps to the export status of firms, by building on the recent models of international trade and heterogeneous firms. We showed 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. We then examined the empirical validity of this prediction using large-scale firm-level data for France and Japan from 1994 to 2006.

We found that Japanese firms outperform French ones in 10 out of 18 industries. Regardless of the export status, French firms have the productivity lead in industries such 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. This result suggests that, as a consequence of the stronger selection of Japanese firms into export markets, the productivity gap between Japanese and French exporters is even larger than the average productivity gap in industries in which Japan has a productivity lead. Moreover, we show that this result holds not only when trade is considered globally, but also when trade is differentiated by destination markets.

This paper also highlighted the relevance of the new models of international trade with firm heterogeneity. On the one hand, it provided new support to those models by showing that firm selection matters in shaping international productivity gaps, and a corollary that cross-country differences in trade costs matter. On the other hand, it revealed some limitations of these new models by showing that productivity and trade cost differences across firms from different countries may not be unique drivers of their export participation.

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, a study utilising data on other countries, especially on developing countries where learning-by-exporting could be a main source of export premium, will add another national perspective to the literature on international productivity gaps. Because we focused on two developed countries, our results may be sensitive to the choice of countries. The effects of trade costs may not be the same for different countries and different periods. Finally, it is also important to control for innovation activities such as R&D in studying the international productivity gap. At the firm level, the feasibility of such analysis will be high if the governments allow researchers to merge confidential firm-level datasets between two countries.

Appendix A. Proof of the monotonicity of the relationship between the truncated mean and the truncation threshold

To prove that $\phi(z)/(1-\Phi(z))$ is a monotonic transformation of z, we must show that the first derivative does not change sign. Define $z = (\theta_{cX} - \mu)/\sigma$ and $\Gamma(z) = \phi(z)/(1-\Phi(z))$, where $\phi(\cdot)$ and $\Phi(\cdot)$ are the probability density function (pdf) and the cumulative distribution function (cdf) of the standard normal, respectively. The first derivative of $\Gamma(z)$ with respect to θ_{cX}

yields the following:

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

Because of the squared terms, the denominator is always positive. Concerning the numerator, $\phi(z)^2$ is always positive, so that the sign of Eq. (A.1) 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 reduces to the sign of $\phi'(z)$. Because $\phi(z) = 1/\sigma\sqrt{2\pi}e^{-1/2z^2}$, observe that $\phi'(z) = -z/\sigma\phi(z)$. Hence,

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

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

1. $\theta_{cX} < \mu$. This relationship implies that $-z/\sigma$ is positive. Hence, $-z/\sigma\phi(z)[1-\phi(z)] > 0$ and $\mathrm{d}\Gamma(z)/\mathrm{d}z > 0$.
2. $\theta_{cX} = \mu$. This relationship implies that $-z/\sigma = 0$ is nil. Hence, $-z/\sigma\phi(z)[1-\phi(z)] = 0$ and $\mathrm{d}\Gamma(z)/\mathrm{d}z > 0$.
3. $\theta_{cX} > \mu$. This relationship implies that $-z/\sigma$ is negative. Rewrite $z/\sigma\phi(z)[1-\phi(z)] = \sigma^{-1}[-z\phi(z)+z\Phi(z)]$. 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 first need to show 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 are 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 $(z/\sigma)\phi(z)[1-\phi(z)] > 0$.

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

Appendix B. A firm-level TFP index for international comparisons

The original Good et al. (1997) (GNS) methodology 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) TFP 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:

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

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 $\overline{s}_{rjt}^k$ 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 compile 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 Eq. (B.1):

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

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 $\overline{s}_{rjt}^{FR}$ 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 datasets 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.

Appendix C. KS tests under confidentiality restriction

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 KS statistic tests the hypothesis that both distributions are identical and the null and alternative hypotheses can be expressed as follows:

$$
\begin{aligned}
&H_0 : G^{JP}(\theta) - G^{FR}(\theta) = 0 \quad \forall\ \theta \in \Re^{+} \\
&H_1 : G^{JP}(\theta) - G^{FR}(\theta) \neq 0 \quad \text{for some } \theta \in \Re^{+}.
\end{aligned}
\tag{C.1}
$$

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:

$$
\begin{aligned}
&H_0 : G^{JP}(\theta) - G^{FR}(\theta) = 0 \quad \forall\ \theta \in \Re^{+} \\
&H_1 : G^{JP}(\theta) - G^{FR}(\theta) < 0 \quad \text{for some } \theta \in \Re^{+}.
\end{aligned}
\tag{C.2}
$$

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:

$$
KS_1 = \sqrt{\frac{n_{FR} \cdot n_{JP}}{N}} \max_{1 \leq i \leq N} |G^{JP}(\theta_i) - G^{FR}(\theta_i)|
\tag{C.3}
$$

and

$$
KS_2 = \sqrt{\frac{n_{FR} \cdot n_{JP}}{N}} \max_{1 \leq i \leq N} \{G^{JP}(\theta_i) - G^{FR}(\theta_i)\},
\tag{C.4}
$$

respectively. The acceptance of the null hypothesis in Eq. (C.3) 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 Eq. (C.4), but not the rejection of the null hypothesis in Eq. (C.3).

Note that in Eqs. (C.3) and (C.4), 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 samples. 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 datasets 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.

Appendix D. Data

D.1. Main variables for the TFP computation

Output is defined as 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.[25]

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 dataset of the GGDC for France and from the JIP 2009 database for Japan.[26] Note that in France, a large drop in hours worked occurred from 1999 onwards because of the 35-hour/week policy: worked hours fell from 38.39 in 1999 to 36.87 in 2000.

The variables for intermediate 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.

---

[25] 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 et al. (2007).

[26] The 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.

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):

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

where K_{it} is the capital stock for firm i operating in year t; δ_{t-1} is the depreciation rate in year $t-1$; I_{it} is the investment of firm i in year t;[27] and p_{It} is the investment goods deflator for industry k.[28] Both the investment price indices and the depreciation rates are available at the two-digit industrial classification level. They are drawn from the JIP 2009 database for Japan and from the INSEE series for France. The investment flows are traced back to 1994 for the incumbent firms and back to the entry of the firm into our dataset for the firms that entered our dataset after 1994.

The cost of intermediate inputs is defined as the nominal cost of intermediate inputs while that of labour is the wage payments. To compute the user cost of capital (i.e., the rental price of capital) in country c, we use the familiar cost-of-capital equation given by Jorgenson and Griliches (1967) (industry subscript k and country superscript c are discarded to simplify the notation):[29]

$$p_{Kt} = p_{It-1}\widetilde{p}_{Kt} + \delta_t p_{It} - [p_{It} - p_{It-1}]. \tag{D.2}$$

This formula shows that the rental price of capital p_{Kt} is determined by the nominal rate of return ($\widetilde{p}_{Kt}$), 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 yields on 10-year government bonds of France and Japan.

D.2. Some discussions on the comparability of the data

D.2.1. Industry classification

To build a common industry classification between the French and Japanese datasets, 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 research (Bellone et al., 2013).

D.2.2. Definition of the primary firm-level variables

To establish the firm-level nominal input and output series, 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 firm output Y_{it}^c as 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 in the 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 deflator p_{Mt}^c.

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.

D.2.3. Purchasing power parity (PPP)

To convert the input and output series in France and Japan into common units, we use the industry-specific PPP series from the GGDC Productivity Level Database, which provides comparisons of output, inputs, and productivity at a detailed industry level for a set of 30 OECD countries.[30] In the GGDC database, both the 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 be 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 occurs as follows.

---

[27] 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.

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

[29] 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

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

Let X_{it}^φ 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 occurs as follows:

$$X^\$ = \frac{X^\varphi}{PPP_{\varphi \to \$}^X}. \tag{D.3}$$

Knowing that $PPP_{\$ \to \varphi}^X = [PPP_{\varphi \to \$}^X]^{-1}$, the conversion of $X^\euro$ into $X^\yen$ implies that we express $\euro$ in US\$ PPP first and then express $X^\$$ in $\yen$ as follows:

$$X^{\yen,FR} = \frac{X^{\euro,FR}/PPP_{\euro \to \$}^X}{PPP_{\$ \to \yen}^X} = X^{\euro,FR} \times \frac{PPP_{\yen \to \$}^X}{PPP_{\euro \to \$}^X}, \tag{D.4}$$

where FR represents French firms. Variable $X^{\yen,FR}$ is the nominal value of X in $\yen$, 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 to 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 for investment. However, Inklaar and Timmer (2008) provided guidance. Noting that $PPP_{\varphi \to \$}^K$, the purchasing power parity for capital K between currency φ and US dollars, we know that:

$$PPP_{\euro \to \$}^K = PPP_{\euro \to \$}^I \times \frac{p_{FR}^K/p_{FR}^I}{p_{US}^K/p_{US}^I}, \tag{D.5}$$

where p_{FR}^K denotes the user cost of capital in France, and p_{US}^K denotes the user cost of capital in the United States (Inklaar and Timmer, 2008, p. 35). Similarly, p_{FR}^I and p_{US}^I denote the current investment price in France and in the United States, respectively. Noting that for our base year 1997, p_{FR}^I and p_{US}^I are set equal to unity, we express the investment PPP as a function of capital PPP as follows:

$$PPP_{\euro \to \$}^I = PPP_{\euro \to \$}^K \times \frac{p_{US}^K}{p_{FR}^K}. \tag{D.6}$$

Based on all of the above, the conversion of the investment series $I^\euro$ into $I^\yen$ is:

$$I^{\yen,FR} = I^{\euro,FR} \times \frac{PPP_{\yen \to \$}^I}{PPP_{\euro \to \$}^I} = I^{\euro,FR} \times \frac{PPP_{\yen \to \$}^K}{PPP_{\euro \to \$}^K} \times \frac{p_{JP}^K}{p_{FR}^K}, \tag{D.7}$$

where p_{JP}^K 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, Eq. (B.2) can be computed for each dataset separately. This calculation produces comparable relative TFP indices for each individual firm belonging to the same industry in France and in Japan.

Appendix E. Supplementary data

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.euroecorev.2014.01.017.

References

Ahn, S., Fukao, K., Kwon, H.U., 2004. The internationalization and performance of Korean and Japanese firms: an empirical analysis based on micro-data. Seoul J. Econ. 17 (4), 439–482.
Aw, B.Y., Chen, X., Roberts, M.J., 2001. Firm-level evidence on productivity differentials and turnover in Taiwanese manufacturing. J. Dev. Econ. 66 (October (1)), 51–86. URL ⟨http://ideas.repec.org/a/eee/deveco/v66y2001i1p51-86.html⟩.
Aw, B.Y., Chung, S., Roberts, M.J., 2000. Productivity and turnover in the export market: micro-level evidence from the Republic of Korea and Taiwan (China). World Bank Econ. Rev. 14 (January (1)), 65–90. URL ⟨http://ideas.repec.org/a/oup/wbecrv/v14y2000i1p65-90.html⟩.
Aw, B.Y., Chung, S., Roberts, M.J., 2003. Productivity, output, and failure: a comparison of Taiwanese and Korean manufacturers. Econ. J. 113 (November (491)), F485–F510. URL ⟨http://ideas.repec.org/a/ecj/econjl/v113y2003i491pf485-f510.html⟩.
Baily, M.N., Solow, R.M., 2001. International productivity comparisons built from the firm level. J. Econ. Perspect. 15 (3), 151–172.
Bartelsman, E., Haltiwanger, J., Scarpetta, S., 2013. Cross-country differences in productivity: the role of allocation and selection. Am. Econ. Rev. 103 (February (1)), 305–334. URL ⟨http://ideas.repec.org/a/aea/aecrev/v103y2013i1p305-34.html⟩.
Bellone, F., Kiyota, K., Matsuura, T., Musso, P., Nesta, L., 2013. International productivity gaps and the export status of firms: evidence from france and japan. Discussion papers 13011, Research Institute of Economy, Trade and Industry (RIETI). URL ⟨http://ideas.repec.org/p/eti/dpaper/13011.html⟩.
Bellone, F., Musso, P., Nesta, L., Quere, M., 2008a. Market selection along the firm life cycle. Ind. Corporate Change 17 (August (4)), 753–777. URL ⟨http://ideas.repec.org/a/oup/indcch/v17y2008i4p753-777.html⟩.
Bellone, F., Musso, P., Nesta, L., Quere, M., 2008. The u-shaped productivity dynamics of French exporters. Rev. World Econ. (Weltwirtschaftliches Archiv) 144 (December (4)), 636–659. URL ⟨http://ideas.repec.org/a/spr/weltar/v144y2008i4p636-659.html⟩.
Bernard, A.B., Eaton, J., Jensen, J.B., Kortum, S., 2003. Plants and productivity in international trade. Am. Econ. Rev. 93 (September (4)), 1268–1290. URL ⟨http://ideas.repec.org/a/aea/aecrev/v93y2003i4p1268-1290.html⟩.
Bernard, A.B., Redding, S.J., Schott, P.K., 2007. Comparative advantage and heterogeneous firms. Rev. Econ. Stud. 74 (1), 31–66. ⟨http://ideas.repec.org/a/oup/restud/v74y2007i1p31-66.html⟩.

Biesebroeck, J.V., 2007. Robustness of productivity estimates. J. Ind. Econ. 55 (September (3)), 529–569. URL ⟨http://ideas.repec.org/a/bla/jindec/v55y2007i3p529-569.html⟩.

Clerides, S.K., Lach, S., Tybout, J.R., 1998. Is learning by exporting important? Micro-dynamic evidence from Colombia, Mexico, and Morocco. Q. J. Econ. 113 (August (3)), 903–947. URL ⟨http://ideas.repec.org/a/tpr/qjecon/v113y1998i3p903-947.html⟩.

Delgado, M.A., Farinas, J.C., Ruano, S., 2002. Firm productivity and export markets: a non-parametric approach. J. Int. Econ. 57 (August (2)), 397–422. URL ⟨http://ideas.repec.org/a/eee/inecon/v57y2002i2p397-422.html⟩.

Dobbelaere, S., Kiyota, K., Mairesse, J., 2012. Product and labor market imperfections and scale economies: micro-evidence on France, Japan and the Netherlands. Discussion papers 12020, Research Institute of Economy, Trade and Industry (RIETI). URL ⟨http://ideas.repec.org/p/eti/dpaper/12020.html⟩.

Fariñas, J.C., Ruano, S., 2005. Firm productivity heterogeneity sunk costs and market selection. Int. J. Ind. Organization September (23) (7–8), 505–534. URL ⟨http://ideas.repec.org/a/eee/indorg/v23y2005i7-8p505-534.html⟩.

Fukao, K., Inui, T., Kabe, S., Liu, D., 2008a. An international comparison of the TFP levels of Japanese, South Korean, and Chinese listed firms. Seoul J. Econ. 21 (1), 5–38.

Fukao, K., Tomohiko, I., Ito, K., Kim, Y.G., Yuan, T., 2008. An international comparison of the TFP levels and the productivity convergence of Japanese, Korean, Taiwanese and Chinese listed firms. J. Chin. Econ. Bus. Stud. 21 (1), 5–38.

Fukao, Kyoji, Sumio, Hamagata, Tomohiko, Inui, Keiko, Ito, Hyeog, Ug, Kwon, Tatsuji, Makino, Tsutomu, Miyagawa, Yasuo, Nakanishi, Joji, Tokui., 2007. Estimation Procedures and TFP Analysis of the JIP Database 2006. Discussion Papers 07003, Research Institute of Economy, Trade and Industry (RIETI). URL ⟨http://ideas.repec.org/p/eti/dpaper/07003.html⟩.

Girma, S., Kneller, R., Pisu, M., 2005. Exports versus FDI: an empirical test. Rev. World Econ. (Weltwirtschaftliches Archiv.) 141 (July (2)), 193–218. URL ⟨http://ideas.repec.org/a/spr/weltar/v141y2005i2p193-218.html⟩.

Good, D.H., Nadiri, M.I., Sickles, R.C., 1997. Index number and factor demand approaches to the estimation of productivity. In: Pesaran, M.H., Schmidt, P. (Eds.), Handbook of Applied Econometrics: Microeconometrics. Handbook of Applied Econometrics, vol. 2. , Blackwell, Oxford, UK. URL ⟨http://ideas.repec.org/h/eee/popchp/1-11.html⟩.

Greenaway, D., Kneller, R., 2007. Firm heterogeneity exporting and foreign direct investment. Econ. J. 117 (February (517)), F134–F161. URL ⟨http://ideas.repec.org/a/ecj/econjl/v117y2007i517pf134-f161.html⟩.

Griliches, Z., Mairesse, J., 1983. Comparing productivity growth: an exploration of French and U.S. industrial and firm data. Eur. Econ. Rev. 21 (1–2), 89–119. URL ⟨http://ideas.repec.org/a/eee/eecrev/v21y1983i1-2p89-119.html⟩.

Hayakawa, K., Machikita, T., Kimura, F., 2012. Globalization and productivity: a survey of firm-level analysis. J. Econ. Surv. 26 (April (2)), 332–350. URL ⟨http://ideas.repec.org/a/bla/jecsur/v26y2012i2p332-350.html⟩.

Helpman, E., Melitz, M., Rubinstein, Y., 2008. Estimating trade flows: trading partners and trading volumes. Q. J. Econ. 123 (May (2)), 441–487. URL ⟨http://ideas.repec.org/a/tpr/qjecon/v123y2008i2p441-487.html⟩.

Inklaar, R., Timmer, M.P., 2008. GGDC productivity level database: international comparisons of output, inputs and productivity at the industry level. GGDC Research Memorandum GD-104, Groningen Growth and Development Centre, University of Groningen. URL ⟨http://ideas.repec.org/p/dgr/rugggd/gd-104.html⟩.

ISGEP(International Study Group on Exports and Productivity), 2008. Understanding cross-country differences in exporter premia: comparable evidence for 14 countries. Rev. World Econ. 144 (4), 596–635. URL ⟨http://EconPapers.repec.org/RePEc:spr:weltar:v:144:y:2008:i:4:p:596-635⟩.

Japanese Cabinet Secretariat, 2010. The Progress of the Economic Partnership Agreements. Technical Report.

Jung, M., Lee, K., 2010. Sectoral systems of innovation and productivity catch-up: determinants of the productivity gap between Korean and Japanese firms. Ind. Corporate Change 19 (August (4)), 1037–1069. URL ⟨http://ideas.repec.org/a/oup/indcch/v19y2010i4p1037-1069.html⟩.

Jorgenson, D.W. and Griliches, Z., 1967. The explanation of productivity change. Rev. Econ. Studies 34 (July (3)), 249–283. URL ⟨http://www.jstor.org/stable/2296675⟩.

Kimura, F., Kiyota, K., 2006. Exports, FDI, and productivity: dynamic evidence from Japanese firms. Rev. World Econ. (Weltwirtschaftliches Archiv) 142 (December (4)), 695–719. URL ⟨http://ideas.repec.org/a/spr/weltar/v142y2006i4p695-719.html⟩.

Kiyota, K., Nakajima, T., Nishimura, K.G., 2009. Measurement of the market power of firms: The Japanese Case in the 1990s. Industrial and Corporate Change 18 (June (3)), 381–414. URL ⟨http://ideas.repec.org/a/oup/indcch/v18y2009i3p381-414.html⟩.

Lee, M.J.K., Fukao, K., 2008. Korean firms and catching up with the Japanese firms. Seoul J. Econ. 21 (1), 93–137.

Lee, P.M., O'Neill, H.M., 2003. Ownership structures and R&D investments of U.S. and Japanese firms: agency and stewardship perspectives. Acad. Manag. J. 46 (2), 212–225.

Mayer, T., Ottaviano, G.I., 2008. The happy few: the internationalisation of European firms: new facts based on firm-level evidence 43 (3), 135–148.

Melitz, M.J., 2003. The impact of trade on intra-industry reallocations and aggregate industry productivity. Econometrica 71 (November (6)), 1695–1725. URL ⟨http://ideas.repec.org/a/ecm/emetrp/v71y2003i6p1695-1725.html⟩.

Novy, D., 2013. Gravity redux: measuring international trade costs with panel data. Econ. Inq. 51 (January (1)), 101–121. URL ⟨http://ideas.repec.org/a/bla/ecinqu/v51y2013i1p101-121.html⟩.

O'Mahony, M., Timmer, M.P., 2009. Output, input and productivity measures at the industry level: the EU KLEMS database. Econ. J. 119 (June (538)), F374–F403. URL ⟨http://ideas.repec.org/a/ecj/econjl/v119y2009i538pf374-f403.html⟩.

Wagner, J., 2007. Exports and productivity: a survey of the evidence from firm-level data. World Econ. 30 (January (1)), 60–82. URL ⟨http://ideas.repec.org/a/bla/worlde/v30y2007i1p60-82.html⟩.

Wagner, J., 2012. International trade and firm performance: a survey of empirical studies since 2006. Rev. World Econ. (Weltwirtschaftliches Archiv) 148 (June (2)), 235–267. URL ⟨http://ideas.repec.org/a/spr/weltar/v148y2012i2p235-267.html⟩.