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Firm Export Heterogeneity and International Productivity Gap: Evidence from France and Japan*

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Abstract

Do exporters in one country perform better than exporters in another country? Similarly, do non-exporters in one country perform better than non-exporters in another country? In spite of the growing studies on firm export heterogeneity, none of the previous studies could answer these questions because they focused on a productivity gap between firms within a single country. This paper attempts to answer these questions, using firm-level data for France and Japan from 1994 to 2006. One of the contributions of this paper is that we compare directly the distribution of firm-level total factor productivity (TFP) within the same industry across two different countries. Our main result is that Japanese exporters tend to outperform their French counterparts in the following sense: their productivity advantage is larger than average in industries in which Japan has a productivity lead, while their productivity disadvantage is smaller than average in industries in which France has the productivity lead. This result is consistent with recent models of international trade and heterogenous firms which assume that fixed export costs differ across countries.

Key words: Exports; Firm heterogeneity; International productivity gap; Productivity distribution
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1 Introduction

Do exporters in one country perform better than exporters in another country? Similarly, do non-exporters in one country perform better than non-exporters in another country? These questions are nontrivial because, in the presence of firm heterogeneity, a part of international productivity gaps between two countries may be attributable to firm characteristics. In this paper, we propose a theoretical and empirical framework to investigate how international productivity gaps relate to the export status of firms.

Our motivation comes from two strands of study. One is the literature on firm export heterogeneity in international trade. With the growing studies on firm export heterogeneity in many countries, we now know that, in general, exporters perform better than non-exporters.[1] However, the previous studies on firm export heterogeneity lack a perspective of international comparison.[2] Therefore, none of the previous studies compared directly the productivity of exporters (or non-exporters) across two different countries.

The other strand is the study on international productivity gaps which is one of the central issues for the theory and empirics of economic growth.[3] Accordingly, numerous studies have attempted to measure international productivity gaps relying on country, industry, or firm levels data sets.[4] However, the previous firm-level studies on international productivity gap focused on large listed firms.[5] This in turn implies that they did not pay much attention to firm export heterogeneity because most of the listed firms are exporters.

In addition, the previous studies on international productivity gap focus only on the *average* productivity of firms.[6] Note, however, that the average productivity gap does not necessarily mean that the majority of firms in one country perform better than those that in the other country. This is because there are two possible explanations behind the international productivity gap. One is that the majority of firms in one country perform better than those in the other. The other is that only a small number of leading firms perform

[1] Greenaway and Kneller (2007) and Wagner (2007) provided excellent literature reviews on firm export heterogeneity.

[2] An exception is a study by International Study Group on Exports and Productivity (ISGEP) (2008) that has analyzed the export premia for 14 countries. However, their study compared the export premia, not the productivity level itself.

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

[4] Baily and Solow (2001) especially emphasized the importance of the international productivity comparisons at the firm level.

[5] Exceptions are studies by Aw, Chung, and Roberts (2000) and Ahn, Fukao, and Kwon (2004). Aw, Chung, and Roberts (2000) utilized Korean and Taiwanese plant-level data but the period is different between two data sets. Ahn, Fukao, and Kwon (2004) utilized Korean plant-level data and Japanese firm-level data. Strictly speaking, therefore, some of the previous studies did not compare directly the productivity of firms (or plants) between two different countries.

[6] For example, Griliches and Mairesse (1983) compared the productivity of firms in France and the United States. Fukao, Inui, Kabe, and Liu (2008) compared the productivity of firms in China, Japan, and South Korea. Fukao, Inui, Ito, Kim, and Yuan (2009) extended the analysis, adding Taiwanese firms. Jung, Lee, and Fukao (2008) and Jung and Lee (2010) compared the productivity of firms in Japan and Korea. All of these studies focus on the difference in average productivity gap.

better than firms in the other country. For the majority of firms, therefore, the international productivity gap may be rather small. These two explanations have different implications for economic theory and policy.

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 fully explored yet. One of the new contributions of this paper is that we propose a framework to integrate these two strands of study and attempt to answer the questions above. We focus on French and Japanese manufacturing firms because of the relatively high comparability of the firm-level data. In this paper, productivity is measured by total factor productivity (TFP). Following Delgado, Fariñas, and Ruano (2002) and Fariñas and Ruano (2005), our empirical analysis relies on the concept of first-order stochastic dominance. Establishing stochastic dominance means that one cumulative distribution lies to the right of another. Therefore, these tests go beyond tests for differences in average productivity that are typically found in the literature on international productivity gap.

Another contribution of this paper is that we propose a framework to balance competing goals for the firm-level analysis and the confidentiality of firm-level data sets between two countries. To relate international productivity gaps to firm characteristics, we would ideally need to merge the two country data sets in an unique data set. However, merging is not possible because of the confidentiality of firm-level data sets. To overcome this problem, we construct new series of variables in which each observation is the representative firm of five individual firms, which this paper arbitrarily calls quintales.

This paper is structured as follows. Section 2 provides a brief overview of the relevant theories of international trade with heterogenous firms. Section 3 presents our empirical methodology. Section 4 explains about the data. Estimation results are presented in Section 5. A summary of our findings and implications is presented in the final section.

2 Theory

Firms face different fixed export costs between domestic and international (export) markets. Because of the existence of the different fixed export costs, exporters are generally more productive than non-exporters (i.e., self-selection). Melitz (2003) provides a theoretical justification for this mechanism. Helpman, Melitz, and Rubinsten (2008) extended the Melitz's (2003) model, allowing the number of firms to vary by destination countries. To do so, Helpman et al. (2008) introduced fixed export costs that vary across destination countries.

The Melitz model has not only strong implications for the difference of productivity between exporters and non-exporters but also some implications for international productivity gap. In the Melitz model, the relationship between productivity and operating profits can be illustrated as in Figure 1 which is analogous to Helpman, Melitz, and Yeaple (2004, Figure 1). Figure 1 presents the profits from domestic sales and from exports: π_D and π_X are operating profits for domestic firms (i.e., non-exporters) and exporters. Due to the difference of the fixed costs between domestic and international markets, exporters are generally more productive than non-exporters. Note that the cutoff productivity level on the horizontal axis corresponds the level of productivity which covers either fixed domestic costs ($-f_D$) or fixed export costs ($-f_X$) displayed on the vertical axis. [7] This result also implies that, in general, the higher the fixed costs, the higher the productivity of firm will be.

=== Figure 1 ===

Once we introduce different fixed costs across countries into the Melitz model, we can relate the international productivity gaps with fixed costs.[8] For the sake of simplicity, suppose that there are only 2 countries indexed as Country 1 and Country 2. Let us assume that both countries have the same distribution functions of firm productivity z and that all firms face the same fixed domestic costs f_D to operate in their respective domestic market. However, following Helpman et al. (2008), suppose that firms face different fixed export costs depending on their nationality. Without loss of generality, assume that fixed export costs in Country 1 are lower than in Country 2: $f_X^1 < f_X^2$, where f_X^1 and f_X^2 are fixed export costs for firms in countries 1 and 2, respectively.

Figure 2 presents the profits from domestic sales and from exports for countries 1 and 2: π_D, π_X^1, and π_X^2 are operating profits for domestic firms, exporters in country 1, and exporters in country 2, respectively. Firms in country 1 start exporting if their productivity is greater than the cutoff productivity level z_X^1 while firms in country 2 start exporting if their productivity is greater than the cutoff productivity level z_X^2. Similar conclusion can be obtained for f_D if we extend the previous framework to cross-country differences in the fixed (domestic) entry costs.

=== Figure 2 ===

In this connection, two implications for the international productivity gap can be drawn from the Melitz model. First, the cross-country difference in the productivity of exporters partly reflects the cross-country difference in the fixed export costs because of self-selection mechanisms. Second, similarly, the cross-country difference in the productivity of non-exporters partly reflects the difference in the fixed domestic costs.

From the first implication, the productivity of Japanese exporters is expected to be, all else equal, higher than that of French exporters because France is a member of the European Union. For French firms, exporting to Italy or Belgium sounds much less costly than exporting overseas like Japanese firms do. For the second one, because we do not know which of France or Japan has the highest fixed domestic costs, a sign of inequality is a priori indeterminate and can only be ascertained empirically.

We now turn to the empirical analysis of the productivity gaps between French and Japanese firms investigating how they relate to firms export status.

[7] In the Melitz model, strictly speaking, the cutoff productivity level depends not only on fixed costs but also on trade costs, market size, and wage level. The discussion in this section implicitly assumes that these factors are held constant. We will discuss this issue in more detail in Section 5.1.

[8] One may be concerned that the difference in the productivity of exporters can be attributable to the productivity growth of exporters through learning-by-exporting, rather than the difference in the fixed export costs. As was discussed in Greenaway and Kneller (2007) and Wagner (2007), however, evidence regarding the learning-by-exporting hypothesis is mixed. This paper thus focuses only on the self-selection aspect.

3 Methodology

We start by describing how we compute internationally comparable TFP indexes at the firm-level without having to merge French and Japanese datasets submitted to confidentiality restrictions. Then, we present the testing procedure we follow to estimate the productivity gaps between French and Japanese firms, explaining why we rely on a "quintales" dataset to test for the significance of our productivity gaps estimates.

3.1 Multilateral firm-level TFP indexes for international comparisons

International comparisons of productivity have always been challenging because of the difficulty to compare data drawn from different national sources. However, performing such exercises at the firm level rise an additional challenge, which is the confidentiality issue. Usually, national statistical offices do not allow the micro-level data they collect to be merge ones with each other.[9] In the case of France and Japan, both INSEE for France and METI for Japan impose such restrictions for the use of their comprehensive micro-level data sets.

The issue of confidentiality raises the challenge of estimating comparable TFP measures without pooling together firm-level data from different countries. For that purpose, this paper proposes to implement a non parametric methodology based on the Multilateral index number approach developed by Good, Nadiri, and Sickles (1997). The reason why we employ an index method, rather than semi-parametric approaches such as Olley and Pakes (1996) or Levinsohn and Petrin (2003), to estimate TFP is precisely that it is impossible to estimate production function, pooling together the firms in our two different countries. On the contrary, the productivity index method allows for separate (but comparable) estimates of individual TFP across countries. It thus enables us to overcome the issue of confidentiality.[10]

The original Good, Nadiri, and Sickles (1997) methodology utilizes a hypothetical reference firm for each industry that has the arithmetic mean values of log output, log input, and input cost shares over 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 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 ($t = 0$).

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

[10] Other advantage is that the index method produces accurate productivity estimates unless the data are subject to a lot of measurement errors. On the flipside, one of the drawbacks of this method is not preferred when the data have serious measurement errors. For more detail, see van Biesebroeck (2007) As we will discuss below, both the French and Japanese data are from the government statistics whose surveys are compulsory for firms. Therefore, the data are less likely to be subject to measurement errors than the data coming from private sources. On that respect, the use of the index method may be more appropriate in our research than in the ones relying on private firm-level data sources.

Let TFP_{it}^k and TFP_t^k be TFP for firm i and the reference firm operating in year t in industry k, respectively. The GNS method consists in defining the TFP index for firm i operating in industry k in year t as:

$$\begin{aligned}\ln TFP_{it}^k - \ln TFP_0^k \approx & \left(\ln Y_{it}^k - \overline{\ln Y}_t^k\right) + \sum_{\tau=1}^{t}\left(\overline{\ln Y}_{\tau}^k - \overline{\ln Y}_{\tau-1}^k\right) \\ & - \sum_{j\in\{K,L,M\}} \frac{1}{2}\left(s_{ijt}^k + \bar{s}_{jt}^k\right)\left(\ln j_{it}^k - \overline{\ln j}_t^k\right) \\ & + \sum_{\tau=1}^{t}\sum_{j\in\{K,L,M\}} \frac{1}{2}\left(\bar{s}_{j\tau}^k + \bar{s}_{j\tau-1}^k\right)\left(\overline{\ln j}_{\tau}^k - \overline{\ln j}_{\tau-1}^k\right), \qquad (1)\end{aligned}$$

where $\ln Y_{it}^k$, $\ln j_{it}^k$, and s_{ijt}^k are the log output, log input of factor j, and the cost share of factor j for firm i in industry k, respectively. $\overline{\ln Y}_t^k$, $\overline{\ln j}_t^k$, and $\bar{s}_{jt}^k$ are the same variables for the reference firm 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 the firm i's output from the output of the reference firm in year t. The second term means 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 methodology to international firm-level comparisons in using a common reference firm to compute relative TFP indexes for firms belonging to different countries. To start with, suppose that all the relevant firm-level variables are expressed in common units irrespective of the country (we will address the issue of the comparability of the data later on in the next section). Let us focus on one industry and two countries (France FR and Japan JP). Define France as the country of reference. Discarding the industry subscript k for simplicity of notation, individual relative TFP indexes for Japan can be computed using the following equation adapted from equation (1):

$$\begin{aligned}\ln TFP_{it}^{JP} - \ln TFP_0^{FR} \approx & \left(\ln Y_{it}^{JP} - \overline{\ln Y}_t^{FR}\right) + \sum_{\tau=1}^{t}\left(\overline{\ln Y}_{\tau}^{FR} - \overline{\ln Y}_{\tau-1}^{FR}\right) \\ & - \sum_{j\in\{K,L,M\}} \frac{1}{2}\left(s_{ijt}^{JP} + \bar{s}_{jt}^{FR}\right)\left(\ln j_{it}^{JP} - \overline{\ln j}_t^{FR}\right) \\ & + \sum_{\tau=1}^{t}\sum_{j\in\{K,L,M\}} \frac{1}{2}\left(\bar{s}_{j\tau}^{FR} + \bar{s}_{j\tau-1}^{FR}\right)\left(\overline{\ln j}_{\tau}^{FR} - \overline{\ln j}_{\tau-1}^{FR}\right), \qquad (2)\end{aligned}$$

where $\ln Y_{it}^{JP}$, $\ln j_{it}^{JP}$, and s_{ijt}^{JP} are defined as previously but are now specific to Japan. $\overline{\ln Y}_t^{FR}$, $\overline{\ln j}_t^{FR}$, and $\bar{s}_{jt}^{FR}$ are the same variables for the French reference firm operating and equal to the arithmetic mean of the corresponding variable over all French firms operating in year t.

To estimate equation (2), a basic requirement is that the main variables for TFP computations are highly comparable in France and in Japan. The presentation of our French and Japanese data sets and the discussion of comparability issues are the purpose of Section 4. For now, let us suppose that the basic requirement of data comparability is fulfilled. Our next step consists in presenting the testing procedure we follow to estimate the productivity gaps between different subsets of Japanese and French manufacturing firms based on those individual TFP indexes.

3.2 Testing procedure under confidentiality restrictions

To estimate the productivity gaps between French and Japanese firms, we follow the testing procedure proposed by Delgado, Fariñas, and Ruano (2002) and Fariñas and Ruano (2005) which relies on the concept of first-order stochastic dominance. However, we have to adapt this procedure to confront the confidentiality restrictions imposed by both the French and the Japanese Offices statistics.

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

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

$$\begin{aligned} H_0 : &\quad G^{JP}(z) - G^{FR}(z) = 0 \quad \forall z \in \mathbb{R} \\ H_1 : &\quad G^{JP}(z) - G^{FR}(z) \neq 0 \quad \text{for some } z \in \mathbb{R}. \end{aligned} \tag{3}$$

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

$$\begin{aligned} H_0 : &\quad G^{JP}(z) - G^{FR}(z) = 0 \quad \forall z \in \mathbb{R} \\ H_1 : &\quad G^{JP}(z) - G^{FR}(z) > 0 \quad \text{for some } z \in \mathbb{R}. \end{aligned} \tag{4}$$

Let i be the index of firm. Let z_i denote the productivity of firm i. Let m and n be the number of French and Japanese firms in the empirical distributions of G^{JP} and G^{FR}, respectively. Let N denote total number of French and Japanese firms ($N = n + m$). The

KS statistic for the one-sided and two-sided tests is given by:

$$KS_1 = \sqrt{\frac{n \cdot m}{N}} \max_{1 \le i \le N} |G_n^{JP}(z_i) - G_m^{FR}(z_i)| \tag{5}$$

and

$$KS_2 = \sqrt{\frac{n \cdot m}{N}} \max_{1 \le i \le N} \left\{ G_n^{JP}(z_i) - G_m^{FR}(z_i) \right\}, \tag{6}$$

respectively. Acceptance of the null hypothesis in equation (4) implies that the distribution of G^{JP} dominates G^{FR}. To establish stochastic dominance of the distribution of G^{JP} with respect to G^{FR} requires the rejection of the null hypothesis in the two-sided test in equation (3), but only one of the one-sided test in equation (4).

To apply the KS tests to the purpose of international firm-level TFP comparisons cannot be done simply by merging the firm-level TFP series that we built in each country separately, still because of the confidentiality restrictions. To solve this problem, we propose to build a "quintale" dataset based on our TFP computations and to perform the KS tests on the Japanese and French quintale firm units rather than directly on the individual firm units. This step is described below.

Confidentiality of firm-level data sets imposes restrictions on the production of tables, series of data, or summary statistics in such a way that identification of individual firms is made impossible. Among various rules, the principal restriction implies that any cell within a produced table must contain at least five observations. The corollary is that all tables with at least five observations in each cell can be produced. Since this rule runs in both countries, our idea is that both teams produce news series of our variables, where each observation is the representative firm of five individual firms. Our choice is to constitute groups of five firms, which we arbitrarily call quintales, on the basis of their TFP. We proceed as follows.

First we rank firms in an ascending order by their TFP index for each industry-year, to then produce quintales on this basis. Hence the first quintale will gather the first five firms with a poor level of productivity. The next quintale will group the next five firms, etc., until exhaustion of all firms in the sample. This implies that the number of observation be a multiple of five firms, which is not necessarily the case in our sample of firms. To fulfill this condition, we first counted the number of firms in our data sets (n and m). Let the number of quintales for France and Japan be n_Q and m_Q, respectively. Let q be the index of quintale. Let N_Q denote the total number of quintales. In turn, the residual number of individual firms, say μ can be an integer running from 0 to 4 ($\mu \in \{0, 1, 2, 3, 4\}$). Our choice is to not include these firms in an incomplete quintale. Rather, we excluded them in such a way as to balance exclusion on each side of the distribution. For example, if $\mu = 4$, we decided to drop two observations on the left-hand side of the distribution and to drop the other two observations located in the right-hand side of the distribution tail. If incidentally μ is an odd number, we excluded primarily firms located on upper part of the distribution.

Therefore, the quintale KS statistic for the one-sided and two-sided tests thus is given by:

$$KS_1 = \sqrt{\frac{n_Q \cdot m_Q}{N_Q}} \max_{1 \leq q \leq N_Q} |G^{JP}_{n_Q}(z_q) - G^{FR}_{m_Q}(z_q)| \tag{7}$$

and

$$KS_2 = \sqrt{\frac{n_Q \cdot m_Q}{N_Q}} \max_{1 \leq q \leq N_Q} \left\{ G^{JP}_{n_Q}(z_q) - G^{FR}_{m_Q}(z_q) \right\}, \tag{8}$$

respectively.[11]

Second, each quintale is computed as a representative firm. Our decision is to compute the arithmetic mean of X so that $X_{qt} = 1/5 \sum X_{it}$, where X are all the variables that enter into the computations of TFP indices. Note that when we compute the mean of variables expressed in logarithms, as is the case for output Y, capital K, labour L and material M, the computation of the arithmetic means of $\ln X$ is tantamount to computing the log of geometric mean of X itself, since $\ln[\prod X_{it}]^{\frac{1}{5}} = 1/5 \sum \ln X_{it}$. This choice has implications, since arithmetic means are sensitive to outliers. Assuming a normal distribution of variables, one could infer that quintales derived from the left-hand part of the distribution have a downward bias whereas those located on the right-hand part of the distribution have an upward bias. An alternative is therefore to produce an alternate quintale data set based on median values, not arithmetic means. Robustness checks will address this issue.

The list of quantitative variables included in the quintales dataset are: TFP indices ($\ln TFP$, in logs); labour productivity ($\ln ALP$, in logs); output (in Yen, both Y and its log transform $\ln Y$); labour (man-hours, both L and $\ln L$); capital (in Yen, both K and $\ln K$), material (in Yen, both M and $\ln M$); capital, labour and material share (respectively s^K, s^L and s^M); investment (in Yen, I); and the number of employees (L^N). For each of these variables, we computed the mean and median values.

One could object that the conversion of series from firm level data to quintale level data should be done prior to the computation of TFP series. It would then be possible to compute TFP using either the index number approach or even extend the comparison to parametric measures of TFP, such as the Olley and Pakes instrumental procedure. In the end, it seems straightforward to convert all data to a common currency, use national deflators, and produce quintales to then compute TFP. However, this would raise the question of which variable to choose in order to produce the quintales: Capital? Labour? Number of employees? To our opinion, TFP indices are the series on which quintales had to be produced precisely because they are the purpose of our comparison.

An important issue with quintale firm dataset is how to treat qualitative variables such as the export status of a firm. At the present time, we decide to rely on the median value to determine whether a quintale is exporting or note. According to this rule, a quintale will be defined as an exporter if at least 3 firms in the quintale export. Otherwise, it will be

[11] One may argue that $G^{FR}(z)$ and $G^{JP}(z)$ can be estimated for France and Japan separately without merging the confidential data sets and, therefore, quintale is not necessarily needed for the KS test. Note, however, that this will violate the principal restriction above if one focuses on an industry with small number of firms.

defined as a non-exporter. This definition is rather arbitrary and robustness tests would be required to investigate to what extend our results are sensitive to changes in the definition of exporters. For instance, we could discriminate between exporting and non exporting quintales according to a certain threshold of export intensity and see how our results change when the threshold value changes.

In section 5 below, we will present the results of KS tests performed on the quintale firm dataset, both at the whole manufacturing level and at the 2-digit industry level. We will also present the results of those test performed separately on the subsets of exporting and non exporting quintale firms defined as above. However before turning to the presentation of our results, we have now to pass through the data step.

4 Data

The data step is an important step in our paper because it explains how we proceed to overcome some data comparability issues which are central to any international comparison of productivity based on firm-level data sets. We start be presenting our data sources. Then, we address comparability issues.

4.1 Data sources

Both the French and the Japanese firm-level data used in this study are collected by national statistical offices.

Data for France are drawn from the confidential *Enquête Annuelle d'Entreprises* (*EAE*) jointly prepared by the Research and Statistics Department of the French Ministry of Industry (SESSI) and the French National Statistical Office (INSEE). The 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 the relevant information to compute productivity indexes as well as information on the international activities of the firms.

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

The strength of both surveys is the sample coverage and reliability of information. In France, the survey covers only manufacturing firms but it is compulsory for all firms with more than 20 employees. In Japan, the survey is compulsory for firms with more than 50 employees and with capital of more than 30 million yen in manufacturing and nonmanufacturing firms (some nonmanufacturing sectors such as construction, medical services, and transportation services are not included). One common limitation is that some information on financial and institutional features are not available, and small firms (with fewer than 50 workers for Japan and fewer than 20 workers for France) are excluded.[12]

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

4.2 Some discussions on the comparability of the data

One crucial requirement for our study is that the firm-level variables built separately in different countries are much comparable. On that respect, the present study benefits from the fact that France and Japan conduct very similar types of firm-level surveys. Thanks to this similarity, we have been able to build a relevant set of comparable variables for TFP computations using firm level information for nominal output and input variables and industry level data for price indexes, hours worked and depreciation rates.

Industry classification

Our first step has consisted in building a common industry classification between the French and Japanese data sets. Actually, we faced two different challenges here. First, the nomenclatures of industry codes in the two firm-level surveys, namely *BSJBSA* and *EAE*, are not the same. Second, within each country, the nomenclatures of industry codes in industry level databases do not always concord with the nomenclatures of industry codes in firm level databases. To overcome these difficulties, we built different concordance tables across different industry classifications as it is reported in Appendix A.

Purchasing power parity (PPP)

The second main step has consisted in converting input and output series in France and Japan in common units. For that purpose, we use industry specific PPP series from the Groningen Growth Development Center (GGDC) Productivity Level Database which provides comparisons of output, inputs and productivity at a detailed industry level for a set of thirty OECD countries.[13] In the GGDC database, both French and Japanese PPP series are expressed relatively to the United States. On this basis, we derived French-Japanese industry specific PPP series as follows.[14]

[12] In 2002, the *BSJBSA* covered about one-third of Japan's total labour force excluding the public, financial, and other services sectors that are not covered in the survey (Kiyota et al., 2009). In the same year, the *EAE* covered about 75 percent of aggregate manufacturing employment and 85 percent of aggregate manufacturing value added (Bellone, Musso, Nesta, and Quéré, 2008) excluding the *Food, Beverages, and Tobacco* industry not covered in the survey.

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

[14] We also used industry classification concordance tables for that purpose. See Appendix A

Our very first choice is simply that the burden of the PPP conversion should bear only on one country, France in our case, so that the other country (i.e. Japan) can compute its TFP indices in an independent fashion. The conversion goes as follows. Let X_{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 subscripts i and t for simplicity of notation, the conversion into US$ PPP reads:

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

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

$$X^{¥,FR} = \frac{X^{€,FR}/PPP^{X}_{€\rightarrow\$}}{PPP^{X}_{\$\rightarrow¥}} = X^{€,FR} \times \frac{PPP^{X}_{¥\rightarrow\$}}{PPP^{X}_{€\rightarrow\$}},$$

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

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

$$PPP^{K}_{€\rightarrow\$} = PPP^{I}_{€\rightarrow\$} \times \frac{p^{K}_{FR}/p^{I}_{FR}}{p^{K}_{US}/p^{I}_{US}},$$

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

$$PPP^{I}_{€\rightarrow\$} = PPP^{K}_{€\rightarrow\$} \times \frac{p^{K}_{US}}{p^{K}_{FR}}$$

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

$$I^{¥,FR} = I^{€,FR} \times \frac{PPP^{I}_{¥\rightarrow\$}}{PPP^{I}_{€\rightarrow\$}} = I^{€,FR} \times \frac{PPP^{K}_{¥\rightarrow\$}}{PPP^{K}_{€\rightarrow\$}} \times \frac{p^{K}_{JP}}{p^{K}_{FR}},$$

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

Thanks to the PPP series built from GGDC series, and to the common industry classification for Japan and France, we have been able to estimate equation (2) on each of our French and Japanese data sets separately. We ended up with comparable relative TFP indexes for each individual firms belonging to a same industry in France and in Japan. To check the reliability of our indexes, our last data step will consist in comparing our TFP estimates (based on firm-level data) with the ones obtained from industry-level databases.

4.3 Comparisons with the industry-level data

In this subsection, we propose to compare our TFP indexes with the ones computed from detailed industry-level data from the GGDC Productivity Levels Database. Our main concern here is whether firm-level TFP estimates are consistent with the TFP estimates from industry-level data because our data do not cover all firms but only firms above the +50 employees threshold. In this subsection, we address this issue.

Inklaar and Timmer (2008) provides TFP based on gross output comparison for a set of detailed industries for 20 OECD countries including France and Japan for the benchmark 1997 year. Table 1 summarized some of their main findings. Table 1 shows industry-specific TFP productivity based on gross output for six selected countries: France, Germany, Italy, Japan, the United Kingdom, and the United States. Globally, the figures in Table 1 show an average lead of French Manufacturing over Japanese one in terms of TFP. Specifically, Relative TFP in manufacturing in Japan is 86 percent of France for the 1997 benchmark year. However, the most interesting feature of Table 1 is that the relative TFP of France and Japan differ substantially across industries. The TFP levels of Japan relative to France range from 49.9 percent in the *Rubber and Plastic* industry to 128.4 percent in the *Transport Equipment* industry.

=== Table 1 ===

Turning to our own computations, we also find substantial differences in the relative TFP of France and Japan across our 19 industries. Table 2 presents the unweighted TFP mean as well as the weighted TFP mean in Japan and France respectively for each of our 19 industries. Actually, cross industries differences are even larger in our slightly more desegregated industrial classification. Specifically the TFP levels of Japan relative to France range from 35 percent in the *Rubber and Plastic* industry to *Textile* industry to 227 percent in the *Textile* industry.

=== Table 2 ===

To facilitate further the comparison between GGDC measures and our own measures, we use the concordance table provided in Appendix A which allows to pass from our FJ Classification to the EUKLEMS ones. Table 3 presents comparatively the relative TFP levels of Japan and France for 11 industries for which we are able to provide comparable figures.[15]

[15] This excludes the *Food products, beverages and tobacco* industry and the *Coke, refined petroleum products*

=== Table 3 ===

Table 3 shows strong consistence between the GGDC measures based on industry-level data and our own measures based on firm-level data. In 8 over 11 industries the relative rankings of France and Japan are consistent from one series to the other. Among them, Japan has the productivity lead in 3 industries (*Textiles, textile products, leather and footwear*, *Transport equipment*, and *Electrical and optical equipment*) while France has the productivity lead in 5 industries (*Wood and products of wood and cork, Chemicals and chemical products, Other non-metallic mineral products, and Manufacturing nec; recycling*). In the remaining 3 industries for which the ranking is not consistent, table 3 reveals minor rather than radical differences. In the *Basic metals and fabricated metal products* and in the *Machinery, nec* industries, Japan is slightly more productive than France (less than 5 percent more productive) according to the GGDC series while Japan is slightly less productive than France (less than 5 percent less productive) according to our own series. The strongest difference exists for the *Pulp and paper, printing and publishing* industry for which Japan is almost as productive as France according to the GGDC series and 16 percent more productive than France according to our own series.

Another interesting feature of Table 3 is that the dispersion of the TFP measures based on firm-level data seems to be larger than the dispersion of the TFP measures based on industry-level data. For each of the industries where a clear productivity lead exists for Japan or for France, the productivity advantage of the leader is always higher in our computations than in the computations by Inklaar and Timmer (2008).

The strong concordance between industry data-based TFP series and firm data-based TFP series give us some confidence in the robustness of our firm-level relative TFP indexes. We are now ready to move on the results we get from the estimates of international productivity gaps across different subsets of manufacturing firms within industries.

5 Results

Table 4 presents the results of the KS tests of stochastic dominance for all manufacturing firms. Recall that, at this stage of our testing procedure, firms are not more individual units but rather quintale units. Indeed, recall that the KS tests are not directly performs on individual firms but on the quintale dataset built for that purpose. However, in the description of the results, we will keep using "firms" instead of "quintale" to make interpretation more intuitive and economically meaningful.

Figures 3 and 4 present the cumulative distribution function for all firms, for the whole manufacturing and by industry, respectively. As mentioned, the productivity difference is attributable not only to fixed costs but also to trade costs, market size, and wage level.

and nuclear fuel industry for which we lack from firm-level data in the *EAE* and/or *BSJBSA*) surveys. We also exclude 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

Although it is difficult to distinguish these factors from the fixed costs,[16] some of their effects can be controlled for by the sectoral analysis because these factors vary largely across industries. We thus test the productivity differences by industry as well as for manufacturing as a whole.

Two messages stand out from these table and figures. First, there is a significant productivity difference between Japanese and French manufacturing firms. Table 4 indicates that Japanese firms perform better than French firms. Besides, the KS test results indicate that this is true for the majority of firms for manufacturing as a whole as Japanese Manufacturing firms has a small but significant productivity advantage of 1.5 percent over their French counterparts[17]. Second, however, such pattern is not uniform across industries. Indeed, in 8 out of 18 industries, French firms perform better than Japanese firms. Then, once again the result suggests the importance of inter-industry heterogeneity.

=== Table 4, Figures 3 and 4 ===

Table 5 presents the test results for exporters and non-exporters. Figures 5 and 6 present the cumulative distribution function for exporters, for all manufacturing and by industry, respectively. Major findings are twofold. First, the KS test results indicate that the productivity of Japanese exporters is 10.6 percent higher than that of French exporters for manufacturing as a whole. At the industry level, however, the productivity of French exporters is significantly higher than that of Japanese exporters in 6 out of 18 industries while the productivity of Japanese exporters is significantly higher than that of French exporters in 11 industries.[18]

=== Table 5, Figures 5 and 6 ===

Second, the KS test results indicate that the productivity of Japanese non-exporters is 3.9 percent higher than that of French non-exporters for manufacturing as a whole. However, at the industry level, the productivity of French non-exporters is significantly higher in 6 out of 16 industries.[19] Corollary, the productivity of Japanese non-exporters is significantly higher only in 8 industries.[20]

[16]In particular, it will be difficult if firms are multi-product firms and export their products to different destination countries because market size and trade costs differ across destination countries.

[17]This feature may surprise considering that Japanese Manufacturing appears generally to perform less than French Manufacturing in more aggregated studies. Recall that in Table 1 above, the industry level measures drawn from the GGGDC database shown a productivity disadvantage of 14 percent for Japan over France in *Total Manufacturing, Excluding Electrical* (Mexelec). This difference of results in favor of Japan in our database can be explained by the fact that our data set excludes some industries in which Japan is particularly less performing according to the GGDC measures as the *Food products, beverages and tobacco* and the *Coke, refined petroleum products and nuclear fuel* industries. Moreover, our data set includes the *Electric Machinery and apparatus* industry in which Japanese firms perform better than French firms while this industry is excluded from Total Manufacturing in the GGDC figures

[18]Insignificant difference is confirmed in one industry (Printing and publishing).

[19]Two industries (Basic metal products and Machinery for office and services) do not have non-exporter quintales for French firms.

[20]Insignificant differences are confirmed in two industries (Printing and publishing and Communication equipment and related products)

Altogether, these results show that Japanese exporters tend to perform relatively better than French exporters. This result holds both at the whole Manufacturing level and at the industry level. For the whole Manufacturing, we found that Japanese exporters outperform by 10.6 percent on average their French Counterparts while the average productivity gap computed for all Manufacturing firms was only about 0.15 percent. At the industry level, we find that in industries in which Japan has the productivity lead (10 over 18 industries), a similar result applied: 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 if 84.2 percent (raw 1 of table 5), while the average productivity advantage of Japan over France in that industry is 70.9 percent (raw 2 of table 4). At the reverse, in industries where France has the productivity lead (8 over 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 over their French counterparts in the *Manufacture of Wood* industry is 32.5 percent (raw 7 of table 5), while the average productivity disadvantage of Japan over France in that industry is 41 percent (raw 4 of table 4).

At the light of the recent models of international trade with export costs and heterogenous firms, we interpret this result as suggesting that export costs are larger for Japanese firms compared to French firms. This interpretation is consistent with the observation that French firms have a large European export market nearby to which then can export without much costs while Japan firms have to export oversea whatever they export[21] More generally, our results are consistent with models of heterogenous firms which assume that the fixed costs for domestic operation and/or exports differ substantially both across industries and across countries.

6 Concluding Remarks

In this paper, we measured international productivity gaps between French and Japanese manufacturing firms considering those firms as a whole, by industry, and by export status. Using firm-level data for France and Japan from 1994 to 2006, one of the contributions of the paper has been to compare directly the distribution of firm-level total factor productivity (TFP) within the same industry across two different countries. Following Delgado, Fariñas, and Ruano (2002) and Fariñas and Ruano (2005), our empirical analysis has relied on the concept of first-order stochastic dominance. Another contribution of this paper has been to propose a framework to balance competing goals for the firm-level analysis and the confidentiality of firm-level data sets between two countries.

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

We found that Japanese exporters performed relatively better than French ones. This result holds at the whole Manufacturing level and at the industry level. In particular, we found that in industries in which Japan had the productivity lead, the productivity gap between Japanese and French exporters was generally larger than the average productivity gap. At the reverse, in industries where France had the productivity lead, we found that the productivity gap between Japanese and French exporters was generally smaller than the average productivity gap.

In light of the recent models of international trade with export costs and heterogenous firms, we interpret this result as suggesting that export costs are larger for Japanese firms compared to French firms. This interpretation is consistent with the observation that French firms have a large European export market nearby to which then can export without much cost while Japan firms have to export oversea whatever they export.

As far as non-exporters are concerned, we did not find any systematic pattern. At the whole manufacturing level, we found a positive productivity gap between Japanese and French non exporters which could suggest that fixed (domestic) entry costs are also larger in Japan compared to France. However, at the industry level, we did not find any pattern which would suggest that fixed entry costs are systematically higher in Japan. However, this may not be seen as surprising as fixed entry costs into an industry may vary a lot across industries and countries.

Two caveats remain. First, the productivity gap of exporters (or non-exporters) between two countries is not uniquely attributable to export costs (or entry costs), but is likely to reflect other key differences such as differences in firm technological abilities or in market sizes. Given that, it is not clear which ones of these factors play the most important role in shaping international productivity gaps. Isolating the role of export or entry costs then remains a challenge for future research.

Second, as we cannot control for the differences in the destination of exports by French firms and by Japanese firms, we cannot say much about the reason why the export costs are higher for Japanese firms than for French firms. Our preferred explanation is that Japanese exporters face higher export costs than French ones because the latter benefit from their easy access to the EU market, exporting much to that market. However, it could be that the costs to export to other (non-European) markets also differ between French and Japanese firms. Moreover, other factors such as institutional or cultural differences (including language) could explain differences in export costs between France or Japan besides destination markets. Investigating further the productivity gaps between French and Japanese exporters by export markets also remains a challenge for future research.

References

Ahn, Sanghoon, Kyoji Fukao, and Hyeog Ug Kwon (2004) "The Internationalization and Performance of Korean and Japanese Firms: An Empirical Analysis Based on Micro-Data," *Seoul Journal of Economics*, 17(4): 439–482.

Aw, Bee Yan, Sukkyun Chung, and Mark J. Roberts (2000) "Productivity Turnover in the Export Market: Micro-level Evidence from the Republic of Korea and Taiwan (China)," *World Bank Economic Review*, 14(1): 65–90.

Baily, Martin Neil and Robert M. Solow (2001) "International Productivity Comparisons Built from the Firm Level," *Journal of Economic Perspectives*, 15(3): 151–172.

Bellone, Flora, Patrick Musso, Lionel Nesta, and Michel Quéré (2008) "Market Selection along the Firm Life Cycle," *Industrial and Corporate Change*, 17(4): 753–777.

Bellone, Flora, Sarah Guillou, and Lionel Nesta (2009) "Are Export premia Robust to Innovation Statistics?", OFCE working paper, nř15, May.

Bernard, Andrew B. and Charles I. Jones (1996) "Comparing Apples to Oranges: Productivity Convergence and Measurement across Industries and Countries," *American Economic Review*, 86(5): 1216–1238.

Delgado, Miguel A., Jose C Fariñas, and Sonia Ruano (2002) "Firm Productivity and Export Markets: A Non-parametric Approach," *Journal of International Economics*, 57(2): 397–422.

Fariñas, Jose C. and Sonia Ruano (2005) "Firm Productivity, Heterogeneity, Sunk Costs, and Market Selection," *International Journal of Industrial Organization*, 23(7–8): 505–534.

Fukao, Kyoji, Tomohiko Inui, Shigesaburo Kabe, and Deqiang Liu (2008) "An International Comparison of the TFP Levels of Japanese, South Korean, and Chinese Listed Firms," *Seoul Journal of Economics*, 21(1): 5–38.

Fukao, Kyoji, Tomohiko Inui, Keiko Ito, Young Gak Kim, and Tangjun Yuan (2009) "An International Comparison of the TFP Levels and the Productivity Convergence of Japanese, Korean, Taiwanese and Chinese Listed Firms," Global COE Hi-Stat Discussion Paper Series, 89, Hitotsubashi University.

Good, David H., M. Ishaq Nadiri, and Robin C. Sickles (1997) "Index Number and Factor Demand Approaches to the Estimation of Productivity," in *Handbook of Applied Econometrics: Microeconometrics*, vol. II, M. Hashem Pesaran and Peter Schmidt (eds.), Oxford, UK: Blackwell.

Greenaway, David and Richard Kneller (2007) "Firm Heterogeneity, Exporting and Foreign Direct Investment," *Economic Journal*, 117(517): F134–F161.

Griliches, Zvi and Jacque Mairesse (1983) "Comapring Productivity Growth: An Exploration of French and U.S. Industrial and Firm Data," *European Economic Review*, 21(1–2): 89–119.

Inklaar, Robert and Marcel P. Timmer (2008) "GGDC Productivity Level Database: International Comparisons of Output, Inputs and Productivity at the Industry Level," Research Memorandum GD-104, University of Groningen.

International Study Group on Exports and Productivity (ISGEP) (2008) "Understanding Cross-Country Differences in Exporter Premia: Comparable Evidence for 14 Countries," *Review of World Economics*, 144(4): 596–635.

Helpman, Elhanan, Marc J. Melitz, and Stephen R. Yeaple (2004) “Export versus FDI with Heterogeneous Firms,” *American Economic Review*, 94(1): 300–316.

Helpman, Elhanan, Marc J. Melitz, and Yona Rubinstein (2008) “Estimating Trade Flows: Trading Partners and Trading Volumes,” *Quarterly Journal of Economics*, 123(2): 441–448.

Jung, Moosup and Keun Lee (2010) “Sectoral Systems of Innovation and Productivity Catch-up: Determinants of the Productivity Gap between Korean and Japanese Firms,” *Industrial and Corporate Change*, 19(4): 1037–1069.

Jung, Moosup, Keun Lee, and Kyoji Fukao (2008) “Korean Firms and Catching up with the Japanese Firms,” *Seoul Journal of Economics*, 21(1): 93–137.

Kiyota, Kozo, Takanobu Nakajima, and Kiyohiko G. Nishimura (2009) “Measurement of the Market Power of Firms: The Japanese Case in the 1990s,” *Industrial and Corporate Change*, 18(3): 381–414.

Levinsohn, James A. and Amil Petrin (2003) “Estimating Production Functions Using Inputs to Control for Unobservables,” *Review of Economics Studies*, 70, 317–340.

Melitz, Marc J. (2003) “The Impact of Trade on Aggregate Industry Productivity and Intra-Industry Reallocations,” *Econometrica*, 71(6): 1695–1725.

Observatoire Français des Conjonctures Economiques (OFCE) (2010) *L'industrie Manufacturiére Française*, Paris: OFCE.

Olley, S. G. and Pakes, A. (1996) “The Dynamics of Productivity in the Telecommunications Equipment Industry,” *Econometrica*, 64 (6), 1263–1297.

O'Mahony, Mary and Marcel P. Timmer (2009), "Output, Input and Productivity Measures at the Industry Level: the EU KLEMS Database", *Economic Journal*, 119(538), pp. F374-F403

van Biesebroeck, Johannes (2007) “Robustness of Productivity Estimates,” *Journal of Industrial Economics*, 55(3): 529–569.

van Ark, Bart, Mary O'Mahony, and Marcel P. Timmer (2008) “The Productivity Gap between Europe and the United States: Trends and Causes,” *Journal of Economic Perspectives*, 22(1): 25–44.

Wagner, Joachim (2007) “Exports and Productivity: A Survey of the Evidence from Firm-level Data,” *The World Economy*, 30(1): 60–82.

Data Appendix

Main variables for TFP computation

Output is defined as total nominal sales deflated using industry-level gross output price indexes drawn respectively from *INSEE* for France and from the Japan Industrial Productivity

(JIP) 2009 database for Japan.[22]

Labour input is obtained by multiplying the number of employees by the average hours worked by industry. Industry level worked hours data for France are drawn from the EU-KLEMS dataset of the Groningen Growth Development Center (GGDC) for France.[23] and from the JIP 2009 database for Japan. Note that in France, a large drop in hours worked occurs from 1999 onwards because of the 35 hours policy: worked hours fell from 38.39 in 1999 to 36.87 in 2000.

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). They are deflated using sectoral price indexes for intermediate inputs published by *INSEE* for France and by the JIP 2009 database for Japan.

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

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

where K_{it} is the capital stock for firm i operating in year t; δ_{t-1} is the depreciation rate in year t; I_{it} is investment of firm i in year t;[24] and p_{It} is the investment goods deflator for industry k.[25] Both investment price indexes and depreciation rates are available at the 2-digit industrial classification level. They are drawn from the JIP 2009 database for Japan and from INSEE series for France. Investment flows are traced back to 1994 for incumbent firms and back to the entry of the firm into our dataset for the firms which have entered our dataset after 1994.

The cost of intermediate inputs is defined as nominal intermediate inputs while that of labour is 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):[26]

$$r_{Kt} = P_{It-1}r_t + \delta_t P_{It} - [P_{It} - P_{It-1}]. \tag{A-2}$$

This formula shows that the rental price of capital r_K is determined by the nominal rate of return (r), the rate of economic depreciation and the capital gains. The capital revaluation

[22] 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).

[23] The concordance between the industry-level EU-KLEMS database and the firm level *EAE* database in presented in Table (to be completed)

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

[25] If firm i's investment was missing in year t, we regard that it did not make any investment: $I_{it} = 0$.

[26] 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 Inklaar and Timmer (2009), to rely on a simpler common formula abstracting from taxation

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

Firm-level data on exports

Exports are also available at the firm level both in the *BSJBSA* and in the *EAE* surveys. However, the export variable has some country specificities.

In Japan, one problem is that the definition of exports in the *BSJBSA* changed in 1997. Before 1997, exports included sales by foreign branches (indirect exports). After 1997, however, 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.

In France, one problem is that the *EAE* survey does not allow distinguishing exports within Europe from export outside Europe. This leads to the outcome that in some industries we have very few non-exporters.

Concordance tables for different industry classification

- From *EAE* to *BSJBSA*:

  to be completed

- From JIP 2009 to *BSJBSA*: The industry classification of the *BSJBSA* is not the same as that of the JIP 2009 database. If one industry in the *BSJBSA* corresponds to more than one industry in the JIP 2009 database, we aggregate the nominal values and real values from the JIP 2009 database and then divide the aggregate nominal values by the aggregate real values to obtain indices. The concordance of the industry classification between the *BSJBSA* and the JIP 2009 database is presented in Table A1.

=== Table A1 (to be added) ===

- From *EUKLEMS* to *EAE*:

  to be completed

Figure 1. Profits from Domestic Sales and Exports

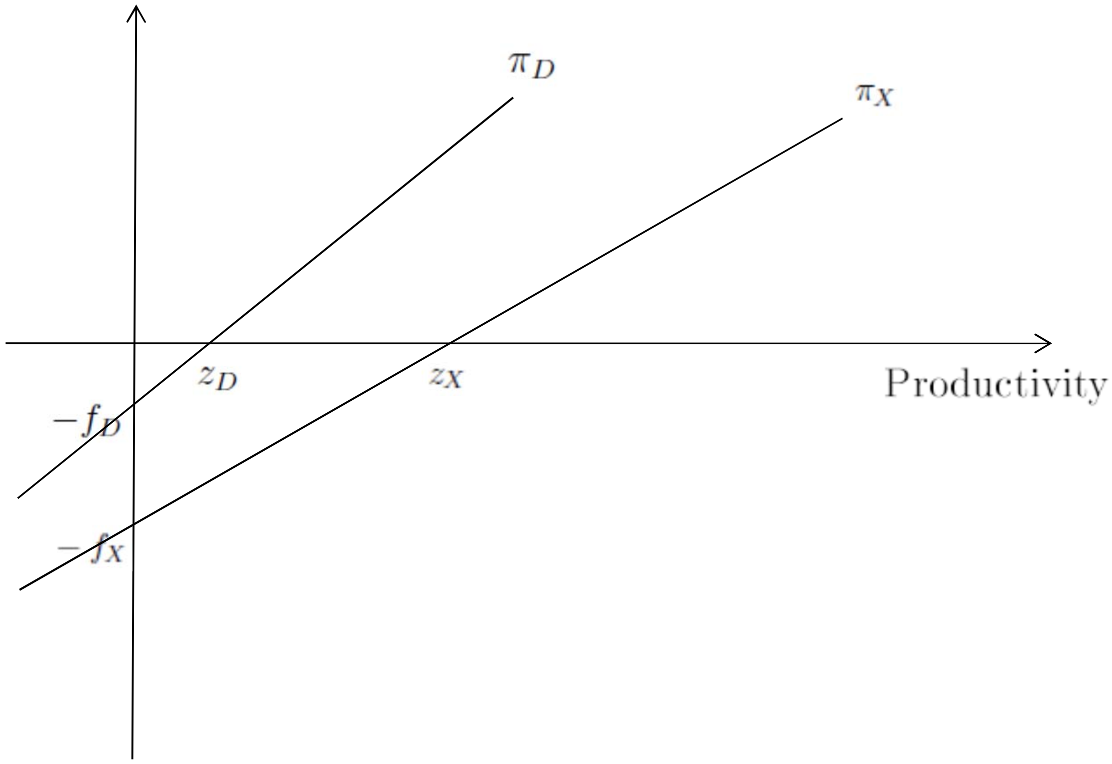

Figure 2. Profits from Domestic Sales and Exports for Different Sunk Export Cost

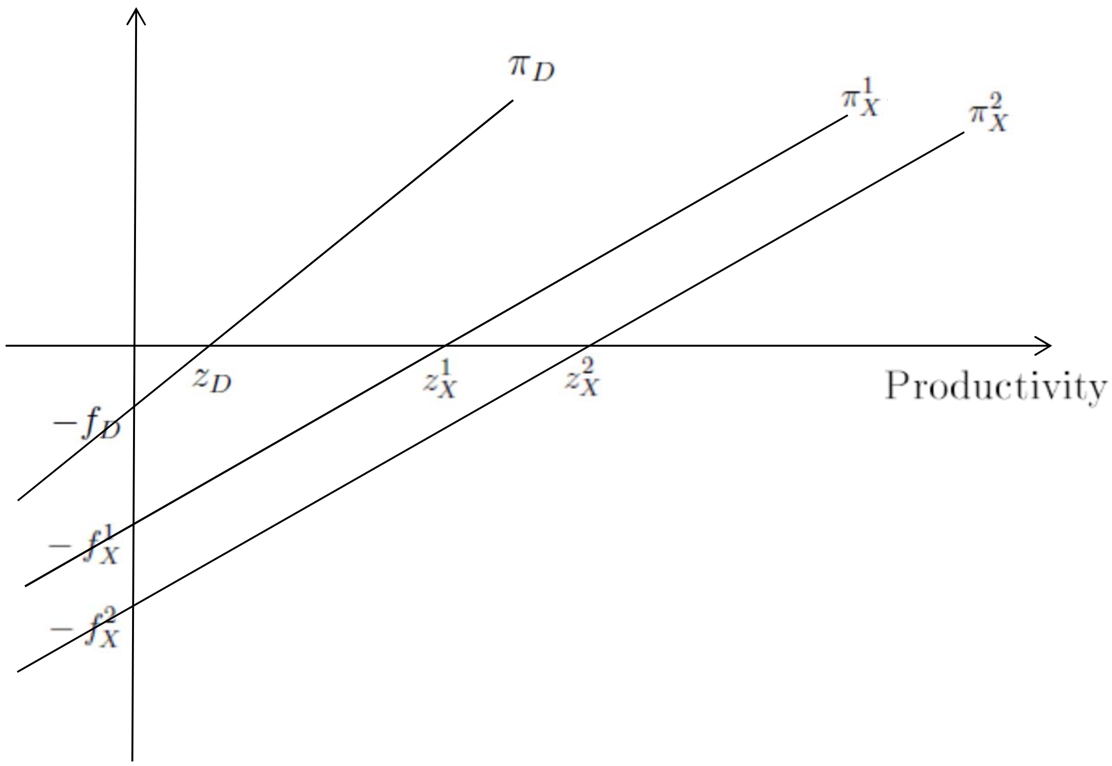

Figure 3. Cumulative TFP Distributions in All Manufacturing

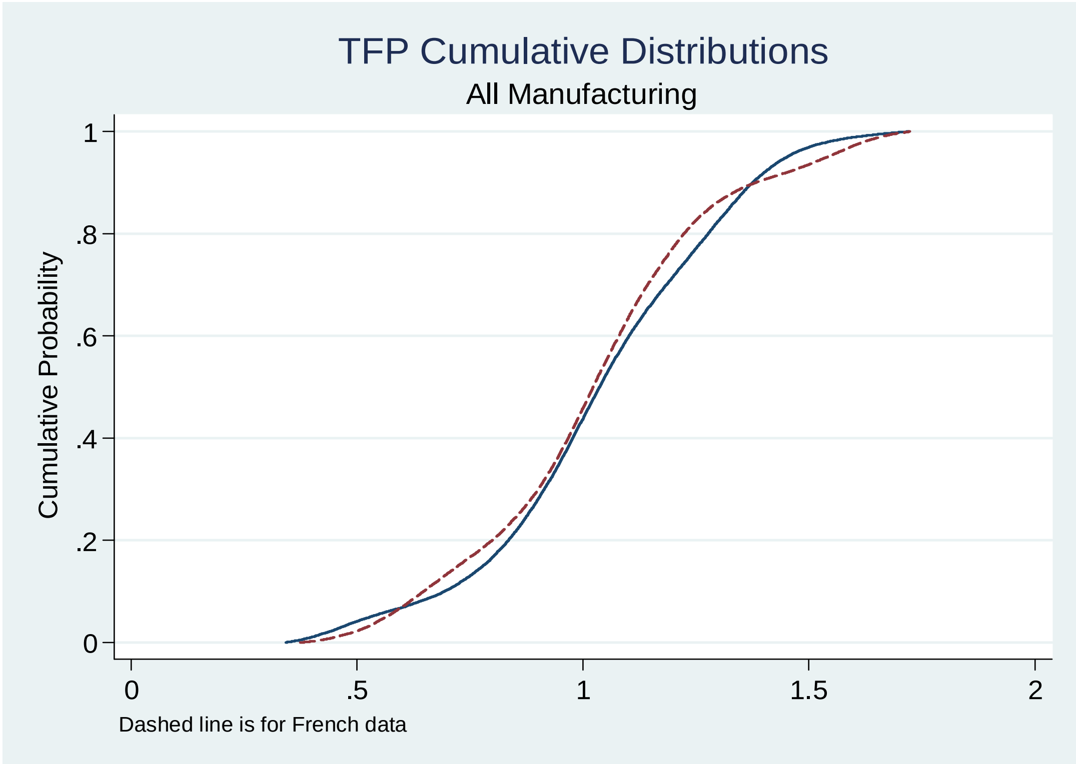

Figure 4. Cumulative TFP Distributions, by Industry

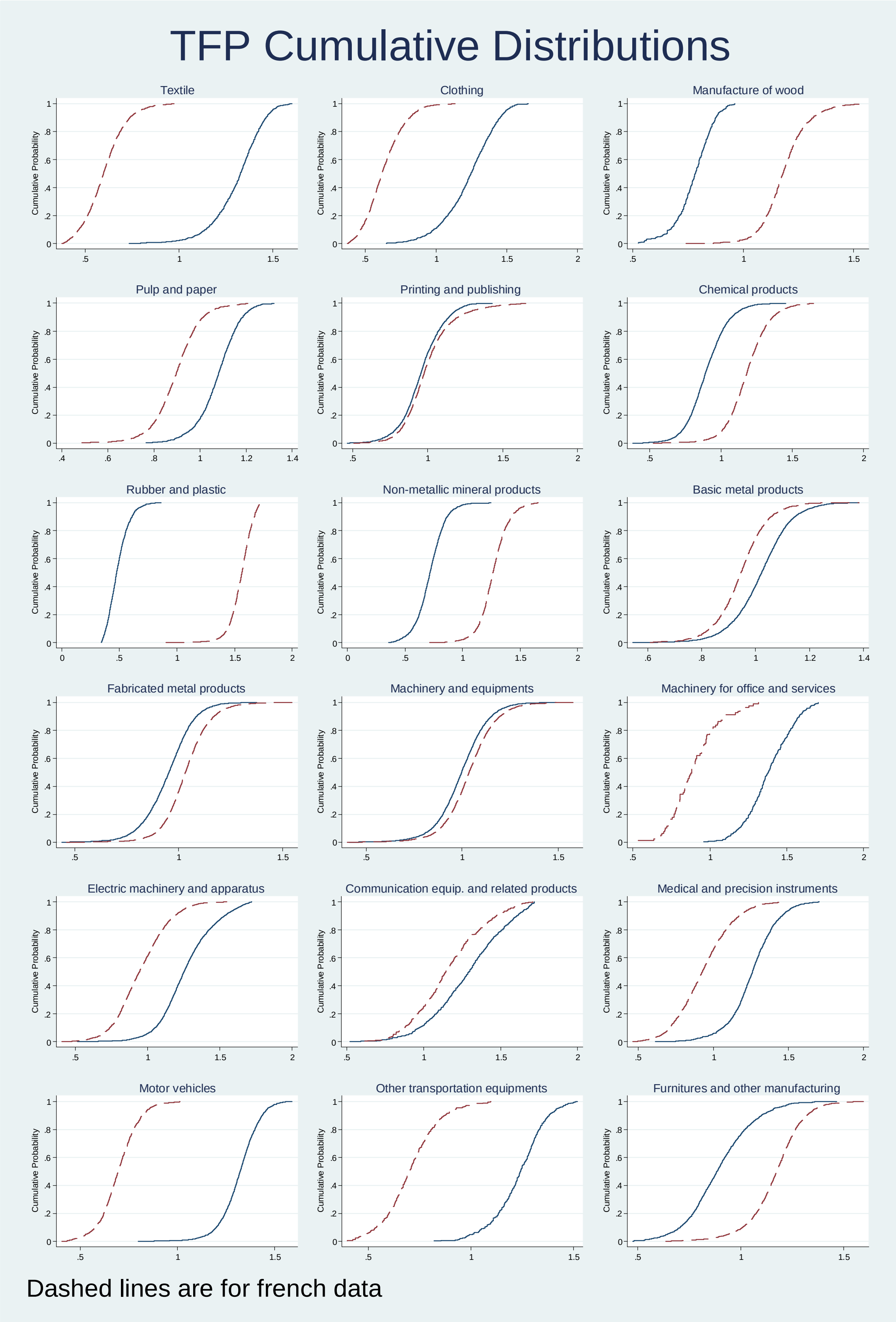

Figure 5. Cumulative TFP Distributions for Exporters in All Manufacturing

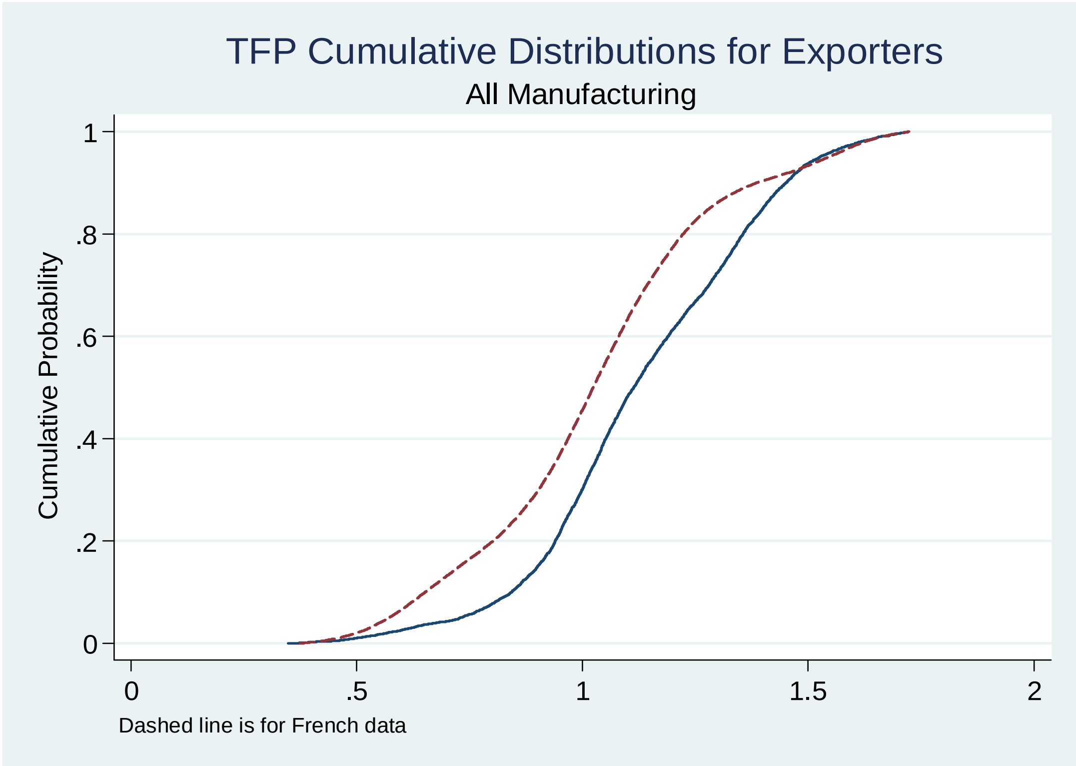

Figure 6. Cumulative TFP Distributions for Exporters, by Industry

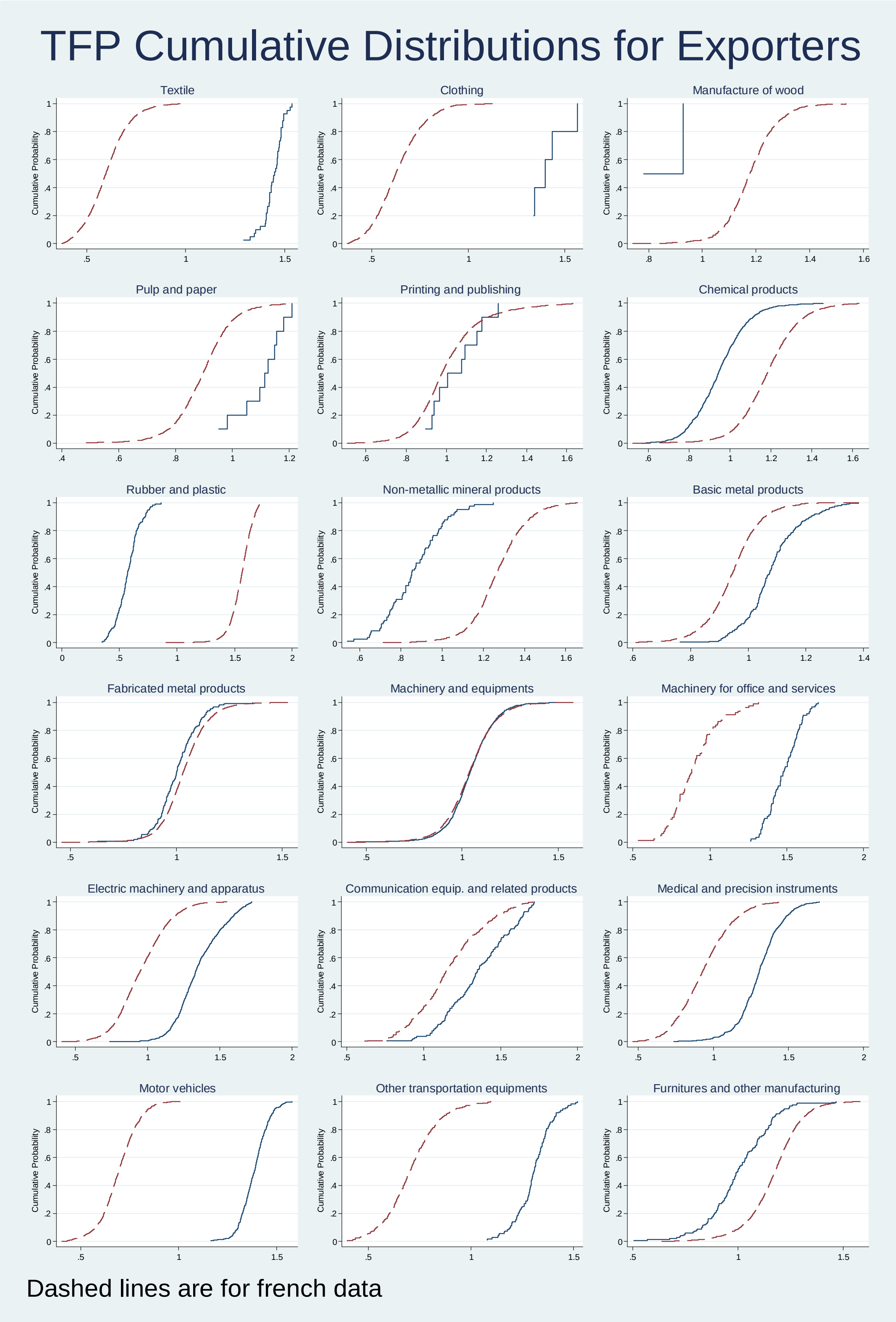

Table 1. International TFP Level Comparisons, Benchmark Year 1997 (Industry-level Data)

EU KLEMS industries	*EUK*	FRA	GER	ITA	JPN	UK	USA	JPN/FRA
TOTAL MANUFACTURING, EXCLUDING ELECTRICAL	MexElec	0.98	1.01	1.01	0.84	0.96	1.00	86.2
Food products, beverages and tobacco	15t16	0.90	0.98	1.08	0.76	0.93	1.00	84.5
Textiles, textile products, leather and footwear	17t19	0.73	0.73	0.82	0.83	0.81	1.00	113.4
Manufacturing nec; recycling	36t37	0.87	1.01	0.92	0.68	1.65	1.00	78.2
Wood and products of wood and cork	20	1.22	1.06	1.00	0.91	0.62	1.00	74.5
Pulp, paper, paper products, printing and publishing	21t22	0.88	0.98	0.68	0.88	1.13	1.00	99.7
Coke, refined petroleum products and nuclear fuel	23	1.18	0.99	0.75	0.86	1.17	1.00	72.8
Chemicals and chemical products	24	1.26	1.05	1.11	1.00	0.94	1.00	79.8
Rubber and plastics products	25	1.63	1.37	1.36	0.81	1.43	1.00	49.9
Other non-metallic mineral products	26	1.16	1.20	1.47	0.87	1.03	1.00	75.3
Basic metals and fabricated metal products	27t28	0.96	1.01	1.10	0.91	0.84	1.00	94.6
Machinery, nec	29	1.08	1.12	1.01	1.06	1.16	1.00	98.9
Transport equipment	34t35	0.74	0.82	1.05	0.96	0.67	1.00	128.4
ELECTRICAL MACHINERY, POST AND COMMUNICATION SERVICES	Elecom	1.00	1.01	0.94	0.93	1.10	1.00	92.3
Electrical and optical equipment	30t33	0.81	0.85	0.92	0.96	0.81	1.00	118.6
Post and telecommunications	64	1.36	1.33	0.94	0.83	1.70	1.00	61.0

Source: Appendix tables to Robert Inklaar and Marcel P. Timmer (2008) available on http://www.ggdc.net/databases/levels.htm

Table 2. Japan-France TFP Level Comparisons, Benchmark Year 1997 (Based on Firm-level Data)

	TFP[a] (Unweighted Mean)			TFP (Weighted Mean[b])		
Industry	JPN	FRA	JPN/FRA	JPN	FRA	JPN/FRA
1 Textile	1.33	0.58	230	1.37	0.60	227
2 Clothing	1.21	0.59	204	1.35	0.65	206
3 Manufacture of wood	0.78	1.16	67	0.83	1.16	71
4 Pulp and paper	1.08	0.89	121	1.16	0.90	129
5 Printing and publishing	0.98	0.97	101	1.10	1.06	104
6 Chemical products	0.85	1.14	75	0.93	1.18	78
7 Rubber and plastic	0.47	1.52	31	0.55	1.55	35
8 Non-metallic mineral products	0.70	1.25	55	0.76	1.34	56
9 Basic metal products	1.02	0.93	109	1.11	0.97	114
10 Fabricated metal products	0.94	1.03	91	1.01	1.05	96
11 Machinery and equipments	0.98	1.01	97	1.08	1.04	103
12 Machinery for office and services	1.31	0.85	154	1.43	0.90	160
13 Electric machinery and apparatus	1.20	0.86	140	1.34	0.91	147
14 Communication equipment and related products	1.20	1.03	117	1.35	1.08	125
15 Medical, precision and optical instruments, watches and clocks	1.20	0.86	140	1.30	0.93	140
16 Motor vehicles	1.29	0.68	190	1.39	0.69	203
17 Other transportation equipments	1.18	0.72	165	1.27	0.83	153
18 Furnitures and other manufacturing	0.86	1.13	76	0.96	1.16	83

[a] TFP is defined as lnTFP

[b] Value Added shares used as weights

Source: Authors calculations

Table 3. France-Japan TFP Comparisons: Industry-level Data *versus* Firm-level Data, Benchmark Year 1997

EU KLEMS industries	*EUKLEMS classification*	*FJ classification*	JPN/FRA GGDC	JPN/FRA Our Team[b]
Textiles, textile products, leather and footwear	17t19	1t2	113.4	216.4
Wood and products of wood and cork	20	3	74.5	71.3
Pulp, paper, paper products, printing and publishing	21t22	4t5	99.7	116.5
Chemicals and chemical products	24	6	79.8	78.5
Rubber and plastics products	25	7	49.9	38.8
Other non-metallic mineral products	26	9t10	75.3	56.4
Basic metals and fabricated metal products	27t28	8	94.6	105.0
Machinery, nec	29	11	98.9	102.3
Transport equipment	34t35	16t17	128.4	177.7
Electrical and optical equipment	30t33	13+15	118.6	143.3
Manufacturing nec; recycling	36t37	18	78.2	92.4

a GGDC series are drawn from theAppendix tables to Robert Inklaar and Marcel P. Timmer (2008) available on

b Authors' computations based on firm-level data for the benchmark year 1997; Weighted TFP mean

Table 4. Productivity Level Differences between French and Japanese Firms, by Industry, 1994-2006: Hypotheses Test Statistics

	Japan		France		
	Number of quintales	lnTFP	Number of quintales	lnTFP	TFP difference
All manufacturing	20,053	1.038	19,898	1.023	0.015***
1 Textile	625	1.310	1,108	0.601	0.709***
2 Clothing	650	1.230	1,266	0.632	0.598***
3 Manufacture of wood	265	0.776	506	1.186	-0.410***
4 Pulp and paper	740	1.076	786	0.895	0.182***
5 Printing and publishing	1,384	0.958	1,308	0.998	-0.039***
6 Chemical products	1,712	0.900	1,762	1.185	-0.285***
7 Rubber and plastic	1,264	0.488	1,534	1.554	-1.066***
8 Non-metallic mineral products	1,020	0.718	902	1.268	-0.550***
9 Basic metal products	1,338	1.019	724	0.945	0.074***
10 Fabricated metal products	1,752	0.948	2,609	1.037	-0.089***
11 Machinery and equipments	2,464	0.996	2,638	1.038	-0.042***
12 Machinery for office and services	279	1.385	79	0.897	0.488***
13 Electric machinery and apparatus	2,431	1.268	1,317	0.953	0.315***
14 Communication equipment and related products	423	1.285	266	1.159	0.125***
15 Medical, precision and optical instruments, watches and clocks	940	1.257	892	0.933	0.324***
16 Motor vehicles	1,638	1.318	675	0.696	0.622***
17 Other transportation equipments	390	1.234	393	0.707	0.528***
18 Furnitures and other manufacturing	738	0.894	1,133	1.168	-0.274***

Note: *** indicates statistically significant at 1 percent level.

Table 5. Productivity Level Differences between French and Japanese Firms, by Industry and by Export Status, 1994-2006: Hypotheses Test Statistics

		Japan		France		
		Number of quintales	lnTFP	Number of quintales	lnTFP	TFP difference
All manufacturing	Exporter	4,663	1.131	19,121	1.025	0.106***
	Non-exporter	15,390	1.009	777	0.970	0.039***
1 Textile	Exporter	41	1.443	1,084	0.602	0.842***
	Non-exporter	584	1.301	24	0.593	0.708***
2 Clothing	Exporter	4	1.412	1,121	0.635	0.777***
	Non-exporter	646	1.228	145	0.606	0.622***
3 Manufacture of wood	Exporter	2	0.855	439	1.180	-0.325**
	Non-exporter	263	0.775	67	1.224	-0.449***
4 Pulp and paper	Exporter	10	1.102	782	0.895	0.207***
	Non-exporter	730	1.076	4	0.927	0.150***
5 Printing and publishing	Exporter	10	1.049	1,120	1.002	0.047
	Non-exporter	1,374	0.958	188	0.974	-0.016
6 Chemical products	Exporter	822	0.948	1,753	1.185	-0.237***
	Non-exporter	890	0.855	9	1.125	-0.271***
7 Rubber and plastic	Exporter	185	0.575	1,508	1.556	-0.981***
	Non-exporter	1,079	0.473	26	1.475	-1.002***
8 Non-metallic mineral products	Exporter	77	0.869	797	1.269	-0.400***
	Non-exporter	943	0.706	105	1.255	-0.549***
9 Basic metal products	Exporter	192	1.084	724	0.945	0.139***
	Non-exporter	1,146	1.008	0		
10 Fabricated metal products	Exporter	142	1.005	2,519	1.037	-0.032***
	Non-exporter	1,610	0.943	90	1.023	-0.081***
11 Machinery and equipments	Exporter	1,175	1.044	2,602	1.039	0.005*
	Non-exporter	1,289	0.952	36	0.984	-0.032***
12 Machinery for office and services	Exporter	87	1.482	79	0.897	0.585***
	Non-exporter	192	1.341	0		
13 Electric machinery and apparatus	Exporter	685	1.356	1,284	0.957	0.399***
	Non-exporter	1,746	1.233	33	0.779	0.453***
14 Communication equipment and related products	Exporter	124	1.357	241	1.162	0.195***
	Non-exporter	299	1.255	25	1.131	0.124
15 Medical, precision and optical instruments, watches and clocks	Exporter	535	1.306	886	0.934	0.372***
	Non-exporter	405	1.192	6	0.794	0.398***
16 Motor vehicles	Exporter	324	1.386	671	0.694	0.691***
	Non-exporter	1,314	1.301	4	0.992	0.309***
17 Other transportation equipments	Exporter	102	1.310	387	0.709	0.601***
	Non-exporter	288	1.208	6	0.556	0.651***
18 Furnitures and other manufacturing	Exporter	146	1.006	1,124	1.169	-0.163***
	Non-exporter	592	0.866	9	1.010	-0.144***

Note: ***, **, and * indicate statistically significant at 1 percent, 5 percent, and 10 percent levels.