Exports versus FDI with market potential*

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Abstract

The theory of multinational corporations now incorporates within-industry firm heterogeneity. A large number of studies deal with the sorting of firms productivity according to the way firms provide foreign countries. We extend Helpman, Melitz and Yeaple (2003) to allow for variable price demand elasticity and obtain general predictions that encompass other papers such as Head and Ries (2002). We test implications of this model using firm level data of the French National Institute of Statistics (INSEE). Both FDI and exports at the firm level with destination country are available. We rely on Olley Pakes method to build a correct measure of TFP and use TFP thresholds to calculate market potential that are consistent with our framework. We are then able to point out interactions of TFP and market potential on the probability to conduct FDI rather than exporting. The results support our extension of the HMY model : a positive shock on productivity increases the probability to conduct FDI either for more productive firms or for more attractive countries only. Countries with larger market potential always tend to receive more FDI from any firms.

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1 Introduction

International economics now incorporate the rapidly growing literature on firms heterogeneity within industry (Melitz, 2004; Eaton and Kortum, 2002; Bernard, Eaton, Jensen and Kortum, 2005). The understanding of firm heterogeneity and its implication for trade seem crucial for the studying of multinational corporations (MNC) since these latter are bigger and dominate international trade.

Numerous recent studies have introduced this "new new trade theory" (Baldwin, 2005) in multinational studies. Helpman, Melitz and Yeaple (2004) (henceforth HMY) use Melitz (2003) trade model with firm heterogeneity to describe the tradeoff between exporting and investing. They point out the existence of a productivity cutoff which is a function of industry and destination country characteristics. This productivity cutoff splits firms set between exporting and investing firms. Firms with productivity below this cutoff export whereas firms with productivity above this threshold conduct FDI. Without individual information on foreign activities, this study is restricted to link variance productivity within a sector to the ratio of export sales on FDI sales. Girma, Kneller and Pisu (2002) use English individual data to test the stochastic dominance of investing firms productivity on domestic and exporting firms productivity distributions. Their findings broadly confirm HMY.

Head and Ries (2003) (henceforth HR) brings two new points. First, they use a simpler model than HMY and make a clear distinction between FDI in rich and poor countries. Second, they introduce the possibility for affiliate to export back to source country. With this model at hand, they show that HMY sorting prediction can be reversed. The data set they use on Japanese multinationals does not contain the country of destination. They are not able to test efficiently their model. Moreover the framework they use does not define productivity cutoff as a function of country characteristics such as market size. Damijan et al. (2004) use a panel of Sloven firms. They confirm HMY predictions for FDI in high wage countries only, which is consistent with HR analysis.

Yeaple (2005) uses a simplified version of Helpman, Melitz and Yeaple (2003) to analyze the structure of US multinational entreprise. In the line of Eaton, Kortum and Kramarz (2005), he proposes a decomposition of FDI revenues in three different terms : the number of firms engaged in FDI, the productivity of these firms, and a country specific scale component. His model claims that more productive firms are more likely to invest in a given market, but that the firm's productivity is less important in relatively more attractive countries. The interaction between firms productivity and country characteristics are made available by the use a confidential firm level data set. However Yeaple (2005) focuses on the probability of investing or not, whereas the theoretical model deals with the difference between exporting and FDI activities operational profits. The condition under which FDI profits become positive is not similar as the one when FDI profits are bigger than exporting profits.

Our work is also connected to another strand of international literature that focuses on market potential. Head and Mayer (2004) provides a complete procedure to estimate Krugman market potential that takes into account accessibility and competition of firms located in other regions. To determine unknown parameters, they use international trade flows. We propose to derive market potential from threshold firms that enter foreign markets through exports. This is consistent with our model and relies on the intuition that threshold firms are a good source of knowledge for accessibility and competition in foreign countries.

This paper adresses the following new points : first we use a data set of French individual firms which provides exports and foreign affiliates with the destination country for each French firm. It then allows us to evaluate the exact probability of the tradeoff between exporting or investing, taking into account country characteristics and firm's productivity. Moreover, in so far as productivity is the key element in the analysis, we use the Olley Pakes method that explicitly takes into account classical problems of endogeneity and selectivity. Third, we extend Helpman, Melitz and Yeaple (2003) model to allow for variable price demand elasticity. We then show that for each country the difference between investment profits and export profits is a square function of productivity, first increasing and then decreasing versus productivity. Moreover we do not need to assume that the affiliate exports back to the country of origin to obtain the decreasing part of the curve.

Our work point out several results. First, we show that market potential can be estimated with productivity of cutoff exporting firms. Secondly, we observe that the larger the market potential the higher the probability to invest in that country. Thirdly, a positive shock on productivity increases the probability to conduct FDI either for more productive firms or for more attractive countries

The remainder of the paper is organized in four sections. In section 2, we extend Melitz and Ottaviano (2005) model to allow for the possibility to conduct FDI. In section 3, I present the data. Results are reported in section 4 and section 5 concludes.

2 Model

We extend Melitz and Ottaviano (2005) framework to introduce endogenous markups within the tradeoff between exports vs FDI. Unlike HMY, the price demand elasticity is variable. More productive firms face less elastic part of the demand function. Thus, a reduction of the price for more productive firms does not necessary imply sharp increase of sales. In the case where the increase of sales cannot cover fixed costs, more productive firms choose to provide the foreign country through exports.

2.1 Domestic demand

World is made of K countries. Demand in each country $k \in K$ comes from the linear demand system developed by Ottaviano, Tabucchi and Thisse (2002) over the set of manufacturing goods I:

$$U = y + \alpha \int_{i \in I} q_i di - \frac{1}{2}\eta(\int_{i \in I} q_i di)^2 - \frac{1}{2}\gamma \int_{i \in I} (q_i)^2 di \tag{2.1}$$

y is our numeraire good and q_i is the quantity of good i consumed. The demand parameters α, γ, η are all positive. The parameter γ embodies substitutability across varieties. In the limit case when $\gamma = 0$, consumers only care about their total consumption level over all varieties, $Q = \int_{i \in I} q_i di$. The parameters α and η index substitution between differentiated good and the numeraire : increases in α and decreases in η shift out the demand for the differentiated good relative to the numeraire.

A country $k \in K$ is defined by a quartet (L^k, w^k, N^k, d^k) where L^k is market size, w^k is wage, N^k is the measure of varieties available in the differentiated sector, and d^k is distance between country k and other countries. Only N^k is endogenous. Demand for variety i in country k is:

$$q_i^k = \frac{\alpha L^k}{\eta N^k + \gamma} + \frac{\eta N^k}{\eta N^k + \gamma}\frac{L^k}{\gamma}\overline{p}^k - \frac{L^k}{\gamma}p_i^k = \frac{L^k}{\gamma}(A^k - p_i^k) \tag{2.2}$$

$\overline{p}^k = (1/N^k)\int_{i \in I} p_i di$ is the average price for differentiated varieties available in country k. Maximum price in country k is:

$$A^k = \frac{\alpha\gamma}{\eta N^k + \gamma} + \frac{\eta N^k}{\eta N^k + \gamma}\overline{p}^k \tag{2.3}$$

No producer will price above this level. Maximum price is a decreasing function of the number of available varieties N^k. In the following, we associate to a producer of variety i, an individual productivity $1/a$ drawn from a common distribution $G(a)$.

2.2 Domestic production

We assume increasing returns with f denoting fixed costs and $c^k(a)$ marginal costs. The producer draws its productivity $1/a$ from the distribution $G(a)$. Taking into account wage in country k, producer i has the following constant marginal cost $c^k(a) = w^k a$. We do not decompose marginal cost between wages and productivity as long as we focus on production in one country. Domestic profits for producer i of country k is then:

$$\pi^D(c^k) = [p(c^k) - c^k]q(c^k) - f \tag{2.4}$$

Profit maximization and demand function give the optimal price for producer i with marginal costs c^k :

$$p(c^k) = \frac{1}{2}(A^k + c^k) \tag{2.5}$$

We can then express domestic profits according to marginal costs:

$$\pi^D(c^k) = \frac{L^k}{4\gamma}[A^k - c^k]^2 - f \tag{2.6}$$

From the last expression, we define c_k^{*D} as the cost threshold above which no national firms are active. This cost threshold c_k^{*D} is:

$$c_k^{*D} = A^k - \sqrt{\frac{4\gamma f}{L^k}} = A^k - m_D^k \tag{2.7}$$

More national firms enter the domestic market when fixed production cost f decreases, when market L^k increases, or when the maximum price increases. Operating profits can be expressed through the difference between individual costs and the cutoff :

$$\pi(c^k) = \frac{L^k}{4\gamma}[c_k^{*D} - c^k + m_D^k]^2 - f \tag{2.8}$$

$$\pi(c^k) = \frac{L^k}{4\gamma}\{[c_k^{*D} - c^k + m_D^k]^2 - m_D^{k2}\} \tag{2.9}$$

$$\pi(c^k) = \frac{L^k}{4\gamma}[c_k^{*D} - c^k][c_k^{*D} - c^k + 2m_D^k] \tag{2.10}$$

This last expression if a function of market size, individual cost, and their mutual interaction.

2.3 Exports

Producers of country k can export to country l. We introduce an "iceberg cost" τ_{kl} and a fixed cost f_X. A producer of country k needs to ship $\tau_{kl} > 1$ units of good to supply one unit of good i in country l. We express the optimal price and output exported from k to l:

$$p_{kl}^X(c^k) = \frac{1}{2}(A^l + \tau_{kl}c^k) \tag{2.11}$$

$$q_{kl}^X(c^k) = \frac{L^l}{2\gamma}[A^l - \tau_{kl}c^k] \tag{2.12}$$

Operating profits through exports are :

$$\pi_{kl}^X(c^k) = \frac{L^l}{4\gamma}[A^l - \tau_{kl}c^k]^2 - f_X \tag{2.13}$$

We define the cost threshold above which no producer of country k exports to country l:

$$c_{kl}^{*X} = \frac{1}{\tau_{kl}}(A^l - \sqrt{\frac{4\gamma f_X}{L^l}}) = \frac{1}{\tau_{kl}}(A^l - m_X^l) \tag{2.14}$$

More firms export when destination market size increases, when fixed costs of production decreases, or when maximum price in l increases. We remind that A^l is a function of the number of varieties available in country l, N^l:

$$A^l = \frac{\alpha\gamma}{\eta N^l + \gamma} + \frac{\eta N^l}{\eta N^l + \gamma}\overline{p}^l \tag{2.15}$$

We can also express this export cutoff from k to l in terms of domestic cost cutoff in country l:

$$c_{kl}^{*X} = \frac{1}{\tau_{kl}}[c_l^{*D} + \sqrt{\frac{4\gamma}{L^l}}(\sqrt{f} - \sqrt{f_X})] = \frac{1}{\tau_{kl}}[c_l^{*D} + m_D^l - m_X^l] \tag{2.16}$$

Hence when fixed production cost f increases, less national firms produce for the domestic market but a larger fraction of firms exports since exporting is a way to reduce the per unit cost of production cost f. Operating profits from exports from k to l are :

$$\pi_{kl}^X(c^k) = \frac{L^l}{4\gamma}[\tau_{kl}(c_{kl}^{*X} - c^k) + \sqrt{\frac{4\gamma f_X}{L}}]^2 - f_X \tag{2.17}$$

$$\pi_{kl}^X(c^k) = \frac{L^l}{4\gamma}\{[\tau_{kl}(c_{kl}^{*X} - c^k) + m_X^l]^2 - m_X^{l2}\} \tag{2.18}$$

$$\pi_{kl}^X(c^k) = \frac{L^l}{4\gamma}[\tau_{kl}(c_{kl}^{*X} - c^k)][\tau_{kl}(c_{kl}^{*X} - c^k) + 2m_X^l] \tag{2.19}$$

It will be more convenient in the following to use the log of the last expression $U_{kl}^X(c^k)$:

$$U_{kl}^X(c^k) = \log[\frac{L^l}{4\gamma}] + \log[\tau_{kl}(c_{kl}^{*X} - c^k)] + \log[\tau_{kl}(c_{kl}^{*X} - c^k) + 2m_X^l] \tag{2.20}$$

As domestic profits, profits from exports are function of individual costs, market size, and their mutual interaction. We introduce in the next paragraph the possibility for firms to invest in country l.

2.4 Foreign Direct Investment

Producer of country k can now settle an affiliate in country l in order to avoid the per unit transport cost τ_{kl}. Such an affiliate requires the paiement of an extra fixed cost $f^I > f^X$. This is the "proximity-concentration" tradeoff. Marginal cost of producer with productivity a is $c^l = aw^l$. Optimal price and profits from FDI are:

$$p_{kl}^{*I} = \frac{1}{2}(A^l + c^l) \tag{2.21}$$

and

$$\pi_{kl}^I(c^l) = [p_l^I - c^l]q(c^l) - f_I = \frac{L^l}{4\gamma}[A^l - c^l]^2 - f_I \tag{2.22}$$

Cost cutoff above which FDI profits are negative is :

$$c_{kl}^{*I} = A^l - \sqrt{\frac{4\gamma f_I}{L^l}} = A^l - m_I^l \tag{2.23}$$

As for exports, we can express this investment cost cutoff from k to l in terms of domestic cost cutoff in country l:

$$c_{kl}^{*I} = c_l^{*D} + m_D^l - m_I^l \tag{2.24}$$

Profits in terms of this cutoff is :

$$\pi_{kl}^I(c^l) = \frac{L^l}{4\gamma}[c_{kl}^{*I} - c^l + \sqrt{\frac{4\gamma f_I}{L^l}}]^2 - f_I = \frac{L^l}{4\gamma}[c_{kl}^{*I} - c^l][c_{kl}^{*I} - c^l + 2m_I^l] \tag{2.25}$$

We will use the log expression of operating FDI profits:

$$U_{kl}^I(c^l) = \log[\frac{L^l}{4\gamma}] + \log[c_{kl}^{*I} - c^l] + \log[(c_{kl}^{*I} - c^l) + 2m_I^l] \tag{2.26}$$

To identify the productivity cutoff that determine the strategy of a producer of country k to supply country l, we need to compare exporting profits and FDI profits:

$$U_{kl}^I(a) > U_{kl}^X(a) \Longleftrightarrow$$

$$\widetilde{a}_{kl}^2 < a < \widetilde{a}_{kl}^1$$

Thresholds $\widetilde{a}^1_{kl}$ and $\widetilde{a}^2_{kl}$ are defined in annex. Firms with productivity between the two cutoffs $1/\widetilde{a}^1_{kl}$ and $1/\widetilde{a}^2_{kl}$ prefer being engaged in FDI rather than exporting. The last result holds as long as $\tau w^k > w^l$. This framework is different from Helpman, Melitz and Yeaple (2003) since less and most productive firms prefer exporting, whereas intermediate firms take more benefits from FDI. In Helpman, Melitz and Yeaple (2003) best productive firms prefer FDI.

Unlike HMY and HR, we find that profits difference is an increasing and decreasing function of productivity. For HMY, the curve is upward for every country, whereas HR shows that the curve may be downward for small countries. This particular form of the difference profits function comes from two opposed effects. First, since FDI reduces variable cost, the gain from conducting FDI is an increasing function of output. More productive firms have larger production and then take more benefit in conducting FDI than less efficient firms. Second, more productive firms charge a cheaper price and face less elastic demand function. Thus, a decrease of the price for most productive firms only lead to small increase in sales. At limit case of non elastic demand, firms pay an extra fixed cost to reduce their variable cost through FDI, but sales do not increase. Thus, the increase of sales due to a cheaper price is larger for less efficient firms who face more elastic part of the demand curve. Variable elasticity combined with firms heterogeneity brings about the decreasing part of the curve. The difference of profits is maximum for firms with productivity equal to $(\tau_{kl}w^k + w^l)/A^l$.

When $A^l \to 0$, our framework yields similar results to HMY, since firms with productivity above the threshold $1/\widetilde{a}^1_{kl}$ choose the FDI strategy, the profit difference function being increasing in productivity. This condition holds for big countries with large number of firms entering the market. At the limit case when $L^l \to \infty$, firms with productivity above the threshold $(\tau_{kl}w^k + w^l)/A^l$ prefer the FDI strategy.

Result 1 : *Less productive firms export, intermediate productive firms conduct FDI and the most productive firms choose export to supply a given foreign market.*

When the market size L^l is very small, the range of firms that prefer FDI gets smaller, and more productive firms prefer exporting. This case is more similar to HR. At the limit case, we have $\widetilde{a}^2_{kl} = \widetilde{a}^1_{kl}$, and all firms chose the export strategy to supply market l. Very small countries are only supplied through exports. Productivity thresholds between which firms conduct FDI are functions of the destination market size. We observe that $\frac{\delta 1/\widetilde{a}^2_{kl}}{\delta L^l} < 0$ and $\frac{\delta 1/\widetilde{a}^1_{kl}}{\delta L^l} > 0$. The range of firms that prefer the FDI strategy gets larger the bigger the market size. The higher the market size, the wider the range of firms that prefer FDI, and the lesser the cutoff above which firms choose the FDI strategy. Hence for two destination countries p and q with different market size, we have:

$$L^p > L^q \Longrightarrow 1/\widetilde{a}^1_{kp} < 1/\widetilde{a}^1_{kq}$$

and

$$L^p > L^q \Longrightarrow 1/\widetilde{a}^2_{kp} > 1/\widetilde{a}^2_{kq}$$

A firm with productivity within $[1/\widetilde{a}^1_{kp}, 1/\widetilde{a}^1_{kq}]$ or within $[1/\widetilde{a}^2_{kq}, 1/\widetilde{a}^2_{kp}]$ export in the smaller country q and settle an affiliate in the larger country p. But firms with productivity above the higher threshold take more benefit in exporting. This second part of the model provides reverse predictions from Helpman, Melitz and Yeaple (2003).

Result 2 : *The fraction of firms that conduct FDI is an increasing function of market size.*

Corollary : *The bigger the market size, the less important a firm's productivity in the decision to conduct FDI*

This last result is similar to Yeaple (2005).

2.5 Empirical equation

We cannot observe profits from exporting or investing but we are aware of the choice made by each firm to export or to invest. We assume that this choice reflects the ordering of profits. We are interested in the following equation, with $\Delta^l(a) = U^I_{kl}(a) - U^X_{kl}(a)$:

$$\Delta^l(a) = 2\log(\frac{w^l}{w^k}) + 2\log\tau^{-1}_{kl} + \log[\frac{a^{*I} - a}{a^{*X} - a}] + \log[\frac{a^{*I} - a + 2\frac{m^l_I}{w^l}}{a^{*X} - a + 2\frac{m^l_X}{\tau w^k}}] \tag{2.27}$$

The difference between FDI and export profits to country l, $\Delta^l(a)$, is a square function of productivity. Thus we introduce, in our empirical equation, square term of productivity. We have decomposed marginal cost in individual productivity and wages. Since we want to observe market size and productivity interactions, we also introduce the product of theses two terms and square market size. Thus our empirical equation is :

$$\Pr(I/X)^l_i = F\{X^l + Y_i + \beta_1\ln(TFP_i) + \beta_2\ln(MP^l) +$$

$$+\beta_3\ln(TFP_i) * \ln(MP^l) + \beta_4\ln(TFP_i) * \ln(TFP_i) + \beta_5\ln(MP^l) * \ln(MP^l)\}$$

with X^l vector of country specific variables like foreign wages and dummies for common language, common past colonial relationship, and distance. Y_i stands for firms control such as capital and industry dummies.

3 Data

We need disaggregated data on firms strategy abroad. Four different French sources are used.

First, we use the French administrative source BIC-BRN that gives information on all French firms subject to the standard tax system. The data set includes all balance sheet variables, employment, industry affiliation, total sales, and a firm identifier. We use BIC-BRN data set for 10 years from 1993 to 2002 for all French firms. We do not select export or parent firms, because it would contribute to create a strong selectivity bias in the estimation of production function coefficients. Following Mairesse and Kremp (2004), we clean this data set in three ways : we get rid of observations with extreme values on crucial ratios such as value added per employee and capital intensity on both level

and growth rates. We do not keep firms that were absent more than two years from the sample. For firms that were absent just one year, we fill the data with mean values before and after the exit. We end up with a file of 827 004 observations.
Second, French customs compile all sales of French firms in each destination. We use the 2002 data set. Biscourp and Kramarz (2002) provides a thorough description of the two sources.

Third, we use the 2002 LiFi enquiry ("Enquete Liaisons Financieres") which reports for a sample of 193 895 firms financial links between an affiliate and the parent firm. Are investigated private firms with shipments above 60 millions euros, or stocks participation above the threshold of 1.2 million euros, or employment above 500 employees. For each of this firm, the data set provides the address with a country code, the industrial affiliation, the identifier of the parent company, the country of the parent company, the participation of the parent company on the affiliate. However this data set does not focus on foreign affiliate and may not be complete. Thus, we complete it with a fourth source, the DREE enquiry. This last data set does not come from statistical French services. It is made by the different economic poles of French embassies all over the world. French firms who want to install an affiliate in a foreign country may ask the embassies some information about the country, and the economic pole keeps track of this affiliate in this country. The two sources together make available a data set of 5029 foreign manufacturing affiliates spread in 154 countries, 1569 comes from LiFi enquiry, 2669 from the DREE basis, and 831 are common to the two sources. These 5029 foreign affiliates are owned by 1547 French parent companies. After cleaning, we keep 3048 foreign manufacturing affiliates. Figures 5 and 6 show the distribution of destination countries for affiliates and exports for the selected file, and for the entire file. We check that the cleaning does not modify the distribution of destination countries. We have, for each of this affiliate in a given foreign country, the parent company in France, the industry affiliation and the country of installation. We select in the BIC-BRN basis only exporting firms and firms that have one or more affiliates abroad. Eventually, we end up with 33 258 French manufacturing firms that export somewhere or have affiliates abroad in 2002. This set of firms report 3048 affiliates and 283 156 export decisions.

We compile country information from three different sources. The table "Trade and Production" from the World Bank is itself the result of a merge between the two basis COMTRADE and UNIDO. This table was extended by the CEPII to cover more countries. We also use CEPII data bases dist_cepii.dta on distance, common language, common borders, or past colonial relationship. Eventually, data on tariff come from Mayer and Zignano (2005), who we gratefully thank for making us available these data.

4 Results

Productivity measure is a key element of the analysis. However, total factor productivity (henceforth TFP) variable is difficult to obtain. We need to estimate a two-factor logarithmic Cobb Douglas production function with capital and labor. An ordinary least squares method is likely to produce biased coefficient estimates, due to a correlation between the exogenous variables and the error term.

Table 1: Descriptive statistics of mean firms, 1993-2002

Year	Value added	Capital	Labor costs	Employment	Investment
1993	27003	30382	10694	49	2713
1994	26575	29509	10233	46	2578
1995	27862	30380	10478	46	2737
1996	28474	31660	10715	47	2878
1997	28860	31869	10521	44	2689
1998	30706	33513	10900	45	2769
1999	32022	33799	11135	45	2731
2000	34358	35295	11561	47	3136
2001	35727	37480	12131	48	3285
2002	34660	38771	12116	46	3056

Source : BIC-BRN, all monetary variables are expressed in thousands of francs

This error term contains TFP and is not observed by econometricians. It is expected to influence the factor input decision, and hence observed input factors. This is the simultaneity problem first pointed out by Marschak and Andrews (1944). This simultaneity bias is supposed to be more important for variable factors. Selectivity occurs because we only observe firms with productivity above a particular threshold. We assume that firms with large capital stock have better probability of survival. Thus, conditioning on survival, capital stock should be negatively correlated with unobserved productivity. Firms with low capital stock will exit the panel whenever they are hurt by low productivity shock. They only stay active if they have a good productivity shock. This negative correlation between capital stock and unobserved TFP leads to a negative bias on capital estimates. However, we only take care of endogeneity bias here because it is likely to be the most important bias.

Following different studies focused on the link between trade and productivity such as Bernard and Jensen (1999) and Pavcnik (2002), we rely on the Olley Pakes (1996) semi-parametric estimation procedure. Van Biesebroeck (2004) shows that the choice of method used to estimate productivity really matters and that the Olley Pakes estimator performs particularly well compared to other estimation technique such as index number and generalized moment method. Taking into account the difficulty and the importance of TFP variable, we spend a little time describing our results on productivity measure in the next paragraph.

4.1 Productivity

Annex contains a description of the method. To estimate production function, the whole sample of 827 004 observations from BIC-BRN was used. Tables 1 and 2 give descriptive statistics on individual firms and correlations between main variables.

Olley Pakes estimates are supposed to correct for a positive bias in labor estimate. The bias in OLS capital estimate would be ambiguous, even if Olley and Pakes (1996) shows that the bias in capital estimate is largely negative. Hence we should observe smaller labor coefficients and larger capital ones with Olley Pakes estimates compared to OLS or fixed effects methods.

Table 2: Correlation of principle variables, 1993-2002

	value added	capital	value added/employment	Olley Pakes TFP
value added	1			
capital	0.864	1		
value added/employment	0.420	0.177	1	
Olley Pakes TFP	-0.309	-0.595	0.444	1

Source : BIC-BRN

In figure 1 are reported results of production function estimates from OLS and fixed effect methods for balanced and unbalanced panel data, along with Olley Pakes estimates. Simultaneity on the labor estimate clearly appears in so far as we observe a clear decrease between OLS and fixed effect estimates in both balanced and unbalanced data. Labor coefficient with Olley Pakes is even smaller than fixed effect coefficient. Considering now capital estimates, we observe that results from balanced and unbalanced data are not very different. Coefficients obtained with fixed effect method are smaller than those obtain with OLS, indicating strong endogeneity bias. Olley Pakes method provides larger capital coefficients. In all sectors, we observe an increase in the capital estimate, the largest increase being in the coal sector. All together these results are consistent with Olley Pakes method on US data. Production function estimates are also similar to other results on French data such as Cueva and Heyer (1997), Desplatz and Mairesse(2003) or Gianella and Lagarde (1999). Correlation of TFP and labor apparent productivity is positive (0.45).

Even if we do not have taken into account selectivity bias, we can check that TFP measure is a correct variable indexing efficiency if good productivity reduces the probability of exit. Figure 2 draws similar results as Olley Pakes : high productivity reduces the probability of exit. Dummies for each year are not reported. The coefficient is significative and negative, even if capital is added, when we look at aggregated or disaggregated data by sectors.

4.2 Probability of investing with market size

Table 3 gives descriptive statistics by firm types for year 2002. Following Head and Ries (2002), we classify these firms into groups : "D" firms do not export neither have foreign affiliates,"DX" firms only export, "DI" firms only conduct FDI and "DXI" firms do both. The largest group is D with more than 2 millions firms. The table reveals that D firms are the smallest in terms of fixed intangible asset (capital), employment and labor force spending. Largest firms are DXI firms that both export and have affiliates overseas. DI and DX firms lie in between in terms of size, except for value added. We note that DI firms have the smallest value added. These results are broadly similar as Head and Ries (2002) except that DI French firms have smaller value added and higher apparent labor productivity (VA/EMPL).

Results of the probit equation are shown in table 5. The file we use contains 1% of FDI decisions.

		Production function estimates									
		Balanced data				Non balanced data					
		OLS		Fixed effects		OLS		Fixed Effects		Olley Pakes	
sectors	Var	Est	StErr	Est	StErr	Est	StErr	Est	StErr	Est	StErr
Food	Capital	0,176	0,001	0,052	0,002	0,144	0,001	0,039	0,001	0,320	0,001
	Labour	0,858	0,002	0,790	0,003	0,864	0,001	0,785	0,002	0,768	0,001
	N	63330				135643					
Textiles	Capital	0,079	0,003	0,014	0,005	0,067	0,002	0,011	0,004	0,254	0,003
	Labour	0,926	0,005	0,876	0,007	0,925	0,004	0,891	0,006	0,867	0,004
	N	15360				27665					
Clothes	Capital	0,098	0,005	0,027	0,005	0,063	0,003	0,019	0,004	0,278	0,003
	Labour	0,894	0,006	0,831	0,007	0,897	0,003	0,848	0,005	0,799	0,005
	N	13400				34295					
Shoes	Capital	0,081	0,005	0,053	0,009	0,077	0,004	0,032	0,007	0,296	0,006
	Labour	0,919	0,007	0,930	0,013	0,898	0,005	0,913	0,009	0,810	0,006
	N	4620				9278					
Wood	Capital	0,098	0,002	0,032	0,003	0,085	0,002	0,025	0,002	0,298	0,003
	Labour	0,910	0,003	0,842	0,005	0,909	0,002	0,848	0,004	0,838	0,003
	N	18820				33975					
Paper	Capital	0,088	0,004	0,025	0,005	0,083	0,003	0,023	0,004	0,289	0,004
	Labour	0,926	0,005	0,824	0,008	0,919	0,004	0,848	0,007	0,829	0,005
	N	7340				11737					
Printing	Capital	-0,016	0,002	0,031	0,002	0,001	0,002	0,022	0,002	0,189	0,002
	Labour	1,004	0,003	0,705	0,003	0,939	0,002	0,724	0,003	0,906	0,002
	N	44900				96209					
Coals	Capital	0,527	0,020	0,058	0,029	0,178	0,013	0,150	0,027	0,553	0,020
	Labour	0,433	0,028	0,511	0,052	0,882	0,019	0,573	0,048	0,564	0,023
	N	460				762					
Chimicals	Capital	0,086	0,003	0,019	0,004	0,079	0,003	0,032	0,004	0,261	0,003
	Labour	0,938	0,005	0,776	0,007	0,939	0,004	0,771	0,006	0,885	0,004
	N	13020				24240					
Plastic	Capital	0,102	0,002	0,036	0,004	0,100	0,002	0,024	0,003	0,311	0,002
	Labour	0,903	0,003	0,810	0,005	0,888	0,003	0,822	0,004	0,814	0,003
	N	18580				32726					
Other mineral materials	Capital	0,206	0,003	0,025	0,003	0,158	0,002	0,023	0,003	0,340	0,002
	Labour	0,782	0,004	0,763	0,006	0,825	0,003	0,793	0,005	0,725	0,003
	N	16400				30107					
Basic metals	Capital	0,258	0,007	0,166	0,011	0,164	0,005	0,098	0,008	0,404	0,006
	Labour	0,710	0,009	0,781	0,016	0,815	0,007	0,828	0,012	0,710	0,007
	N	4390				7301					
Steel	Capital	0,068	0,001	0,024	0,002	0,062	0,001	0,018	0,001	0,273	0,002
	Labour	0,954	0,002	0,853	0,003	0,930	0,001	0,832	0,002	0,875	0,001
	N	51390				140946					
Machinery and equipment	Capital	0,054	0,002	0,007	0,003	0,054	0,001	0,004	0,002	0,245	0,002
	Labour	0,957	0,002	0,855	0,004	0,934	0,002	0,849	0,003	0,890	0,002
	N	36570				72240					
Office & informatical equipement	Capital	0,072	0,012	-0,007	0,019	0,046	0,009	-0,014	0,012	0,249	0,012
	Labour	0,956	0,016	0,781	0,029	0,949	0,011	0,849	0,020	0,878	0,014
	N	650				2504					
Mach. & electronical equipement	Capital	0,075	0,003	0,023	0,004	0,066	0,002	0,014	0,003	0,248	0,004
	Labour	0,929	0,004	0,833	0,007	0,920	0,003	0,853	0,005	0,863	0,004
	N	10250				20289					
Radio, TV equipment	Capital	0,074	0,004	0,020	0,006	0,070	0,003	0,007	0,005	0,276	0,005
	Labour	0,911	0,005	0,850	0,009	0,914	0,004	0,864	0,007	0,855	0,004
	N	6730				14946					
Optical and precision equipment	Capital	0,093	0,002	0,021	0,003	0,082	0,002	0,020	0,003	0,287	0,003
	Labour	0,899	0,003	0,841	0,005	0,892	0,002	0,808	0,004	0,839	0,002
	N	20770				41144					
Car industry	Capital	0,087	0,004	0,027	0,006	0,082	0,003	0,019	0,004	0,261	0,004
	Labour	0,929	0,005	0,832	0,009	0,918	0,004	0,863	0,007	0,857	0,005
	N	7360				13037					
Other transport materials	Capital	0,086	0,006	0,019	0,008	0,076	0,004	0,018	0,006	0,276	0,006
	Labour	0,935	0,006	0,828	0,011	0,935	0,005	0,835	0,009	0,879	0,006
	N	4910				9568					
Furnitures	Capital	0,090	0,002	0,044	0,003	0,077	0,002	0,029	0,002	0,256	0,002
	Labour	0,914	0,003	0,794	0,004	0,897	0,002	0,786	0,004	0,846	0,002
	N	23980				50472					
Recuperation	Capital	0,132	0,005	0,045	0,005	0,122	0,003	0,035	0,004	0,342	0,004
	Labour	0,889	0,006	0,797	0,009	0,870	0,005	0,790	0,007	0,763	0,005
	N	6590				13264					

Figure 1: Production function estimates

	Probability of Exit		
sectors	Variable	Estimate	StErr
Food	TFP	-0,325	0,014
	Capital	-0,155	0,004
	N	116461	
Clothes	TFP	-0,473	0,018
	Capital	-0,197	0,007
	N	29036	
Shoes	TFP	-0,639	0,048
	Capital	-0,216	0,014
	N	7914	
Wood	TFP	-0,533	0,033
	Capital	-0,242	0,010
	N	29130	
Paper	TFP	-0,392	0,054
	Capital	-0,132	0,013
	N	10076	
Printing	TFP	-0,130	0,011
	Capital	-0,148	0,004
	N	80809	
Coals	TFP	-0,195	0,090
	Capital	-0,162	0,040
	N	609	
Chimicals	TFP	-0,160	0,024
	Capital	-0,101	0,007
	N	20586	
Plastic	TFP	-0,354	0,033
	Capital	-0,152	0,009
	N	27863	
Other mineral materials	TFP	-0,292	0,027
	Capital	-0,131	0,007
	N	25493	
Basic metals	TFP	-0,339	0,051
	Capital	-0,165	0,016
	N	25493	
Steel	TFP	-0,358	0,018
	Capital	-0,175	0,005
	N	119394	
Machinery and equipment	TFP	-0,302	0,021
	Capital	-0,141	0,006
	N	61190	
Office and informatical equipement	TFP	-0,271	0,066
	Capital	-0,095	0,019
	N	2024	
Machinery and electronical equipement	TFP	-0,248	0,040
	Capital	-0,114	0,010
	N	17114	
Radio, TV equipment	TFP	-0,319	0,039
	Capital	-0,117	0,010
	N	12624	
Optical and precision equipment	TFP	-0,262	0,026
	Capital	-0,123	0,008
	N	35245	
Car industry	TFP	-0,387	0,050
	Capital	-0,131	0,012
	N	11083	
Other transport materials	TFP	-0,337	0,043
	Capital	-0,129	0,013
	N	8111	
Furnitures	TFP	-0,289	0,021
	Capital	-0,131	0,006
	N	43095	
Recuperation	TFP	-0,135	0,038
	Capital	-0,111	0,013
	N	11285	
All	TFP	-0,279	0,005
	Capital	-0,143	0,001
	N	702943	

Figure 2: Probability of exit

Table 3: Median statistics by firm types, in 2002

	Firms Types			
	D	DI	DX	DXI
capital	13	48	157	14105
employment	1	2	9	266
labor costs	15	146	322	11852
value added/employment	37	59	43	53
value added	41	0.432	402	13829
N	2281882	459	117518	1088

Source : BIC-BRN, all monetary variables are expressed in thousands of francs

Table 4: Descriptive statistics by destinations

	Statistics					
	min	q25	median	q75	max	mean
GDP (millions of euros)	232	3670	12199	86300	9209999	192999
absorption (millions of euros)	0.6	5	52	152	2450	193
GDP per capita (euros)	104	525	2027	7970	36275	6382
wages (euros)	0	1	5	14	40	10
number of exporters	4	159	742	2361	16516	1851
number of investors	0	0	1	18	214	17

Sources : World Bank and Unido

Since, this is likely to bias our results, we choose to select only French multinationals -ie only French firms that own a foreign affiliate. It reduces our sample so that FDI decisions represent now 9% of total decisions. We use absorption as measure of market size. Absorption is defined as the sum of GDP plus imports less exports : $ABS = GDP + IMP - EXP$. The first three columns are devoted to apparent labor productivity and the last three to total factor productivity (TFP). All continuous variables are written in log. We add interaction and square terms successively for both labor productivity and TFP.

In all specifications, distance decreases the probability of investing, whereas common border favors settlement of affiliates. Tariff is found to be non significative. Common language decreases the probability of investing unlike past colonial relationship. Capital is always significative and estimates do not vary much in different specifications. Capital is found to have a very clear impact on the probability to invest as have suggested previous studies like Damijan and al. (2004) on Sloven data. French wages are not significant, and GDP per capita has a negative impact on the probability of investing, which is conform to the model used.

Without interaction and square terms, we observe that labor productivity's coefficient receives a positive sign whereas TFP's is not significative. The coefficient of absorption is also significant and positive, when no interaction terms are added. Larger countries have a greater probability to receive FDI. When interaction terms are added, productivity and absorption are no longer significative. We believe that this is due to the fact that determinants of FDI are not properly taken into account by market size when measured by absorption. For instance, concurrence is not explicitly taken into account whereas it is present in our theoretical framework through the term A^l. Thus in the following we try to estimate market potential and use it in the probability of choosing outward FDI.

4.3 Probability of investing with market potential

4.3.1 Estimates of market potential

Market potential is a broader notion than market size. Head and Mayer (2004) provides a thorough analysis of different market potential measures. They themselves propose a way to estimate market potential that takes into account concurrence from other countries and trade costs such as distance, common border, and common language. We choose to follow our model and try to estimate market potential in a first step using the minimum productivity of French firms entering foreign markets through exports. We do not select French MNE in this step and use all French exporters in 2002, which represent 118 606 firms. The link between export participation and productivity has been studied by several authors : Bernard and Jensen (1995, 1999), Clerides and al. (1998), Aw, Chung and Roberts (1998), Eaton and al. (2004) have found strong support for the idea that exporter tend to be more productive. Tybout (2001) provides a survey on this literature. Roberts and Tybout (1997) have proved the importance of sunk costs from exports. Eaton et al. (2005) clearly links market size and productivity of entering firms. We follow this rich strand of literature and the predictions of our model to link market potential to firms productivity threshold. Market potential is defined here as the blend of market size and concurrence in the country, which appears through the maximum price in country l, A^l. Equation (2.14) on export firm cost threshold to country l is :

$$c_{kl}^{*X} = \frac{1}{\tau_{kl}}(A^l - \sqrt{\frac{4\gamma f_X}{L^l}})$$

This relationship contains both agglomeration and dispersion effects. When market size L^l increases, TFP export cutoff decreases. Larger countries attract more firms. However, concurrence effects induce a negative relationship between TFP cutoff and market size. The relative impact of those two forces is an empirical matter. In figure 3, we plot for each country the sector mean of TFP exporters minimums versus the log of GDP in 1999. The relationship is clearly negative. Agglomeration forces appear stronger than concurrence effects in productivity cutoff.

We assume that this cutoff can be expressed as function of countries and sector dummies, since f_X is sector specific :

$$A^l - \sqrt{\frac{4\gamma f_X(s)}{L^l}} = \exp(1_{\{s=1\}} + 1_{\{l=1\}})$$

For a particular sector s, we have :

$$\ln c_{kl}^{*X}(s) = \ln(\tau_{kl})^{-1} + 1_{\{s=1\}} + 1_{\{l=1\}}$$

And we can estimate the following equation:

$$-\ln TFP_{Fce,l}^{*X}(s) = \beta_1 \ln(\tau_{Fce,l}) + \beta_2 1_{\{s=1\}} + \beta_3 1_{\{l=1\}} + \epsilon_l(s)$$

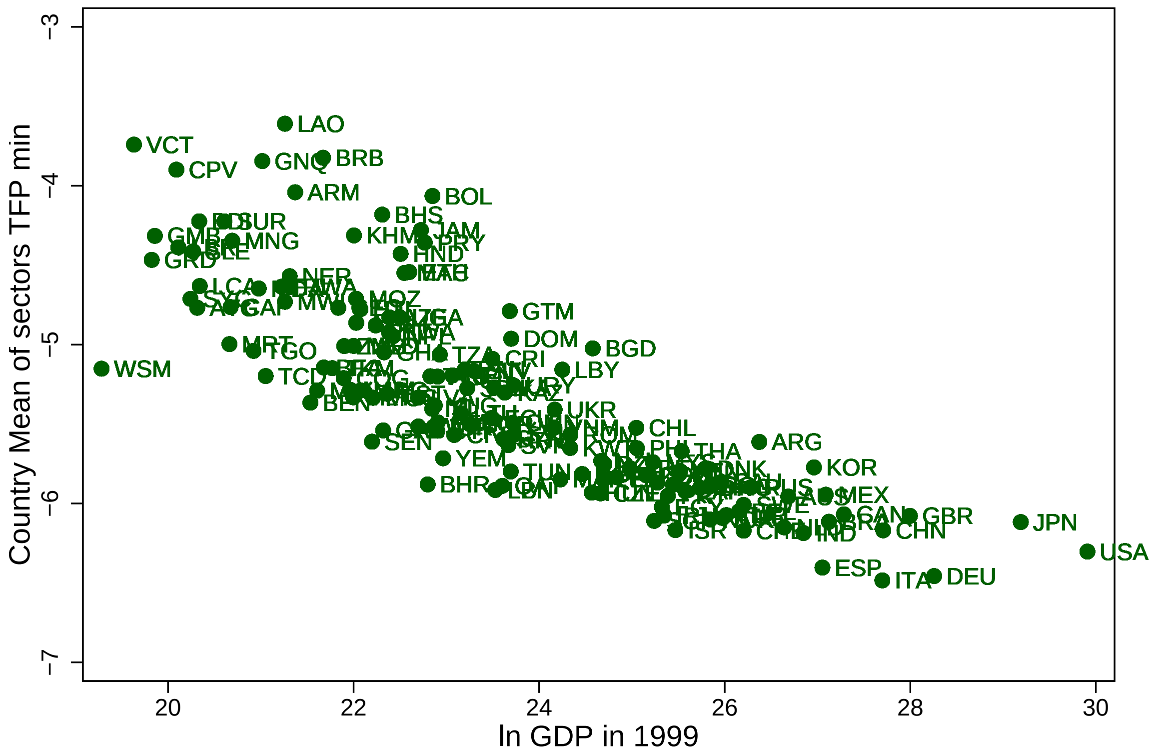

Figure 3: Minimum productivity threshold of exporters and market size

for a particular sector s. This regression is ran for 154 countries and 26 sectors. Coefficient obtained β_3 stands for our market potential. It captures both market size L^l and maximum price A^l that is related to the number of firms selling to country l. The sector dummy captures wages and export fixed costs. We do not introduce the variable "tariff" in this stage, because we do not have the information for all countries and all sectors. The variable "common border" is neither introduced among trade costs variables. It would contribute to reduce sharply market potential estimates.

These estimates of market potential come directly from our model that emphasizes that cutoff firms are a useful source of knowledge for foreign market potential. The productivity of these cutoff firms is both related to accessibility and concurrence in foreign country. Figure 4 shows that potential markets obtained with this technique are positively related to market size GDP which is reassuring. Market potentials are defined for each destination through less efficient firm able to enter the market through exports. Results of this first step is presented in table 6. We do not report fixed effects.

Table 7 contains the list of 10 countries with largest market potential from France's point of view. European closed countries and large countries such as Japan have a very good rank. The USA has not a very good rank (25) but the value of market potential obtained is very closed to most attractive countries. We will denote market potential obtained through this technique as "Cutoff Market Potential" (CMP).

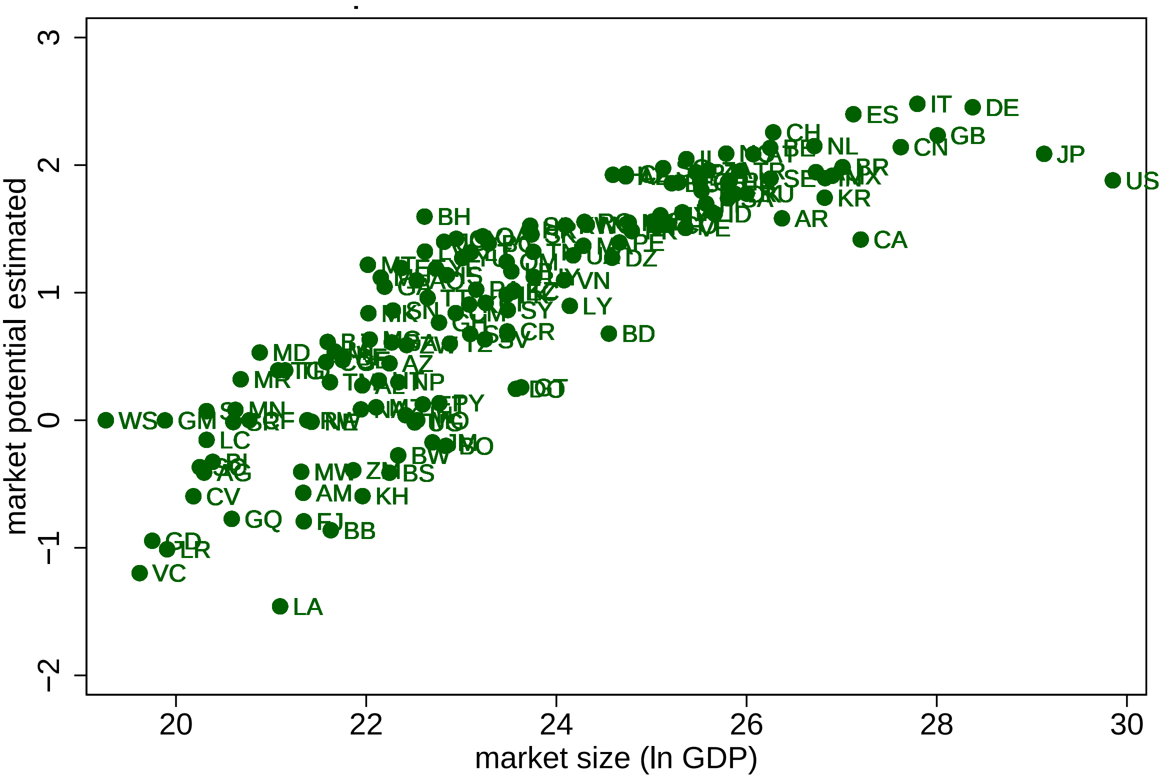

Figure 4: Market Size and Market Potential

4.3.2 Probability of investing

As market size estimations, we show results with and without interaction and square terms, for apparent labor productivity and total factor productivity (TFP) in table 8. We still focus on French MNCs only. The file we use contain 91% of export decisions and 9% of investment decisions. French wages and tariff have significative estimates. French wages have a negative effect on the probability to invest. However standard models of wage determination explain difference in wages with differences in human capital. Thus it may not be surprising to find ambiguous results.

Unlike results with absorption, all coefficients with productivity and market potential terms are significative except the coefficient of cutoff market potential in the last column. We focus on this last column of table 8. We are interested in the impact of productivity on the probability to invest abroad. The marginal effect is given by :

$$\frac{\partial Pr(I/X)_i^l}{\partial \ln(TFP_i)} = f(u)(\beta_1 + \beta_3 \ln(CMP^l) + 2\beta_4 \ln(TFP_i))$$

with $f(u)$ the density of the normal function. This marginal impact of productivity on the probability to invest is function of productivity and market potential. To get rid of units of measure, we can compute the elasticity of TFP on the probability to invest.

We begin with market potential elasticities :

$$e(CMP)^l = \frac{\partial Pr(I/X)_i^l}{\partial \ln(CMP^l)} \frac{\ln(CMP^l)}{Pr(I/X)_i^l}$$

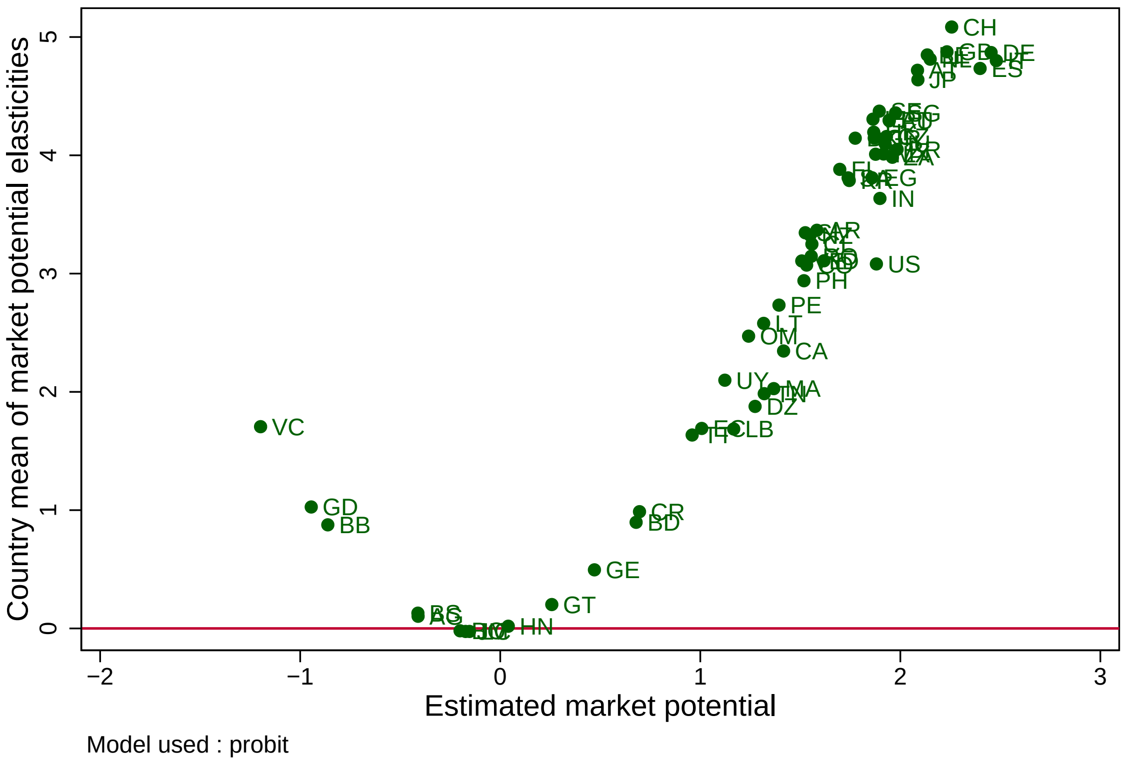

Figure 5: Elasticity of Market Potential versus Market Potential

We plot on figure 5 mean market potential elasticities versus market potential. Mean market potential elasticities are calculated as the firm mean of market potential elasticities for firms present in the country. Market potential elasticities always have a positive impact on the probability to attract FDI. Furthermore the elasticity is higher the higher the market potential.

Elasticity of TFP on the probability to invest is :

$$e(TFP)_i^l = \frac{\partial Pr(I/X)_i^l}{\partial \ln(TFP_i)} \frac{\ln(TFP_i)}{Pr(I/X)_i^l}$$

We expect this elasticity of productivity to be positive for less productive firms, and negative for more productive firms. An increase in productivity reduces the marginal cost, and thus the price the firm can charge. For less productive firms, price demand elasticity is high, and a decrease in price leads to important increase in sales. We thus expect a positive sign of the elasticity of TFP on the probability to invest. Since more productive firms face a less elastic part of the demand curve, the productivity elasticity should be negative. We plot on figure 6 the mean elasticity of productivity versus the log of productivity for each firm. Mean elasticity of TFP is positive only for less productive firms - and few most productive ones.

We can also plot this elasticity of TFP on the probability to invest versus countries market potential. Figure 7 contains for each country mean TFP elasticity versus market potential. The elasticity is negative for countries with smaller market potential. For most countries, mean TFP elasticities are positive. It is larger the higher the market potential.

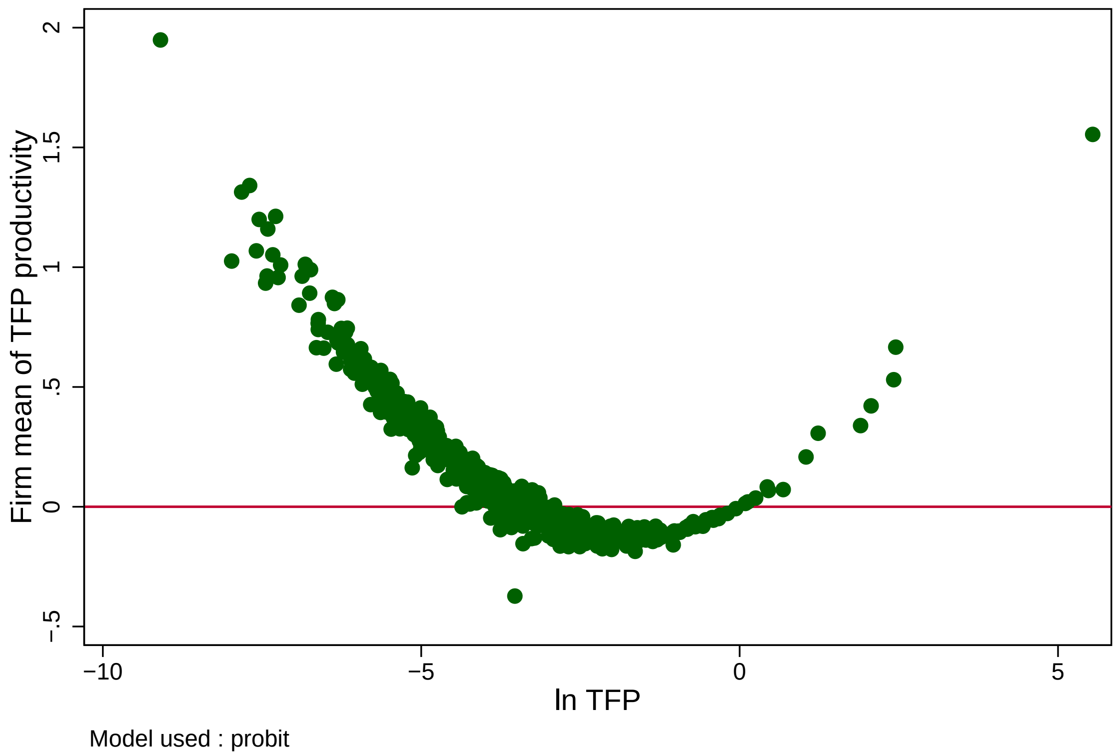

Figure 6: Elasticity of TFP versus ln TFP

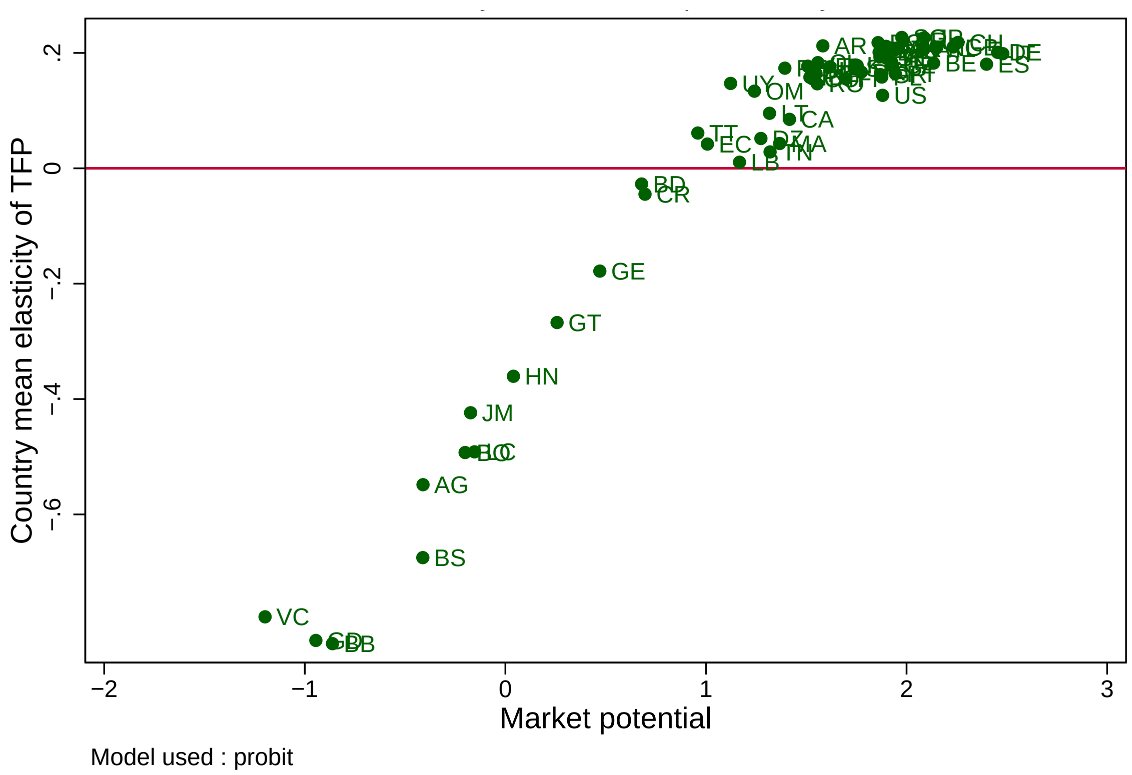

Figure 7: Elasticity of TFP versus Market Potential

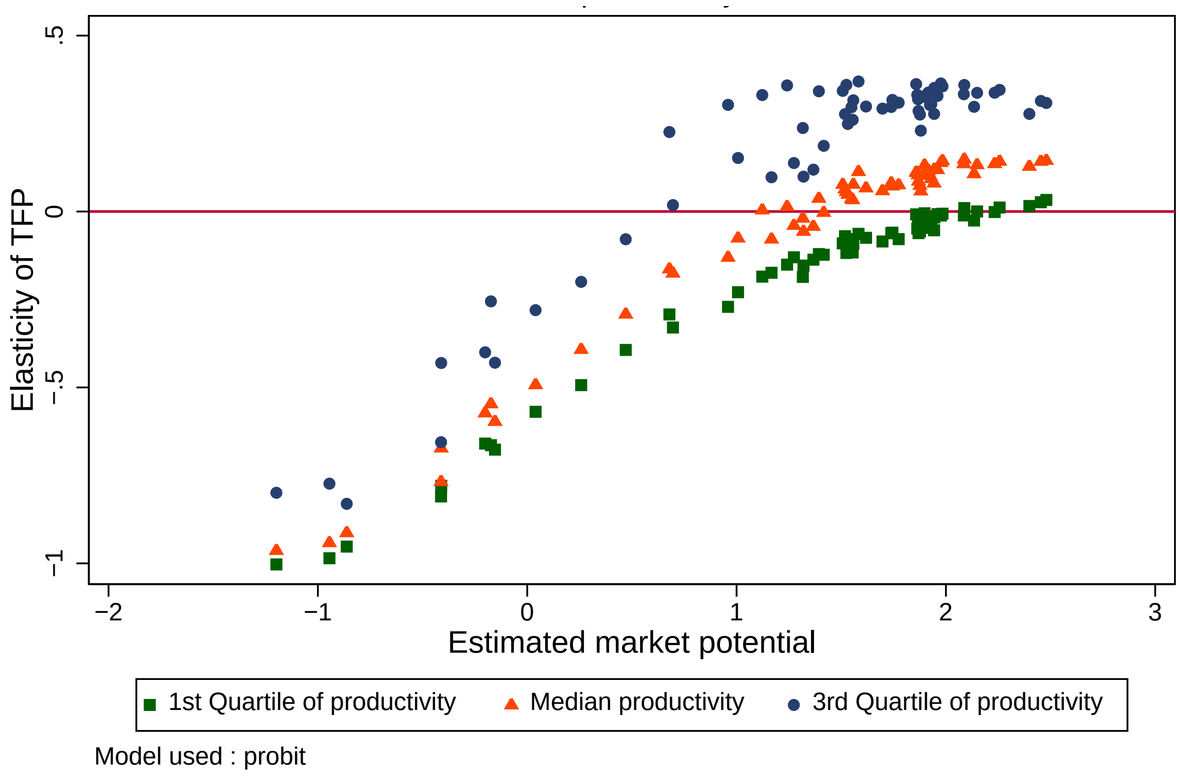

Figure 8: Elasticity of TFP for different productivity level within countries

Our theoretical framework implies that we should observe different TFP elasticities for firms with different productivity levels within the *same* the country. Figure 6 compares mean TFP elasticities of different firms who are not necessarily present in the same country. In figure 8, we plot for each country, TFP elasticities for low, median and high productive firms. Each country is represented with three points - each one corresponding to a different productivity level. For less attractive countries or less productive firms, TFP elasticities are negative. We find positive TFP elasticities for most productive firms only, in most attractive countries. In most attractive countries, TFP improvement leads to a better chance to invest in the country. In the contrary, for less attractive countries, TFP increase leads to more exports.

5 Conclusion

We have extended Melitz and Ottaviano (2003) to many countries and to the possibility to conduct FDI. This framework yields more general predictions than Helpman, Melitz and Yeaple (2003) and Head and Ries (2003). This extension enables us to describe the contrary impacts of the proximity - concentration tradeoff with heterogeneous firms on sales. Extensive dimension of sales favor FDI for more productive firms who sell more ; but large increase in sales due to high elasticity is more pronounced for less productive firms. This is the intensive dimension of sales that favor FDI for less productive firms. This framework enables us to define two productivity thresholds. Firms with productivity in between these two thresholds take more benefit in conducting FDI. These two cutoffs are increasing and decreasing functions of market size. The larger the market size, the broader the fraction of firms that prefer FDI.

In our empirical work we build on Olley Pakes method to calculate a measure of TFP that correct for endogeneity. We then use the export profits positive condition to provide a measure of market potential that entirely relies on firms cutoff productivity. We use the decreasing relationship between market size and productivity threshold that is strongly supported by the data. We could then in a final step assess accurately the impact of productivity and market potential together on the probability to conduct FDI rather than export.

Our work yields several results. Firstly, we show that the higher the market potential the higher the probability for any firms to invest in that country. Secondly, probability to invest is a square function of productivity. An increase in productivity for less productive firms is associated with an increase in the probability to invest. However, most productive firms usually have negative productivity elasticities - on the probability to invest. This is consistent with our theoretical framework. More productive firms charge a cheaper price and face a less elastic part of the demand curve. Thus a reduction of marginal cost through FDI would not enable best firms to increase their sales. Thirdly, negative TFP elasticities are obtained for all firms in less attractive countries, or less productive firms in nearly all countries. It confirms the idea that the more attractive the country the less “important” the level of productivity to conduct FDI in that country.

We would like to extend this work to the case of multi-product firms. First, this is justified by the fact that multinationals are bigger and then produce more than only one good. Then, multi-product firms could enable us to get rid of a too strict condition about exports and FDI substitution which is at the core of exports vs FDI models that neglect complementarities.

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6 Annex

6.1 Thresholds $\widetilde{a}^1_{kl}$ and $\widetilde{a}^2_{kl}$

Firm with productivity $1/a$ takes more benefits from FDI than exporting when:

$$\pi^I_{kl}(a) > \pi^X_{kl}(a) \Longleftrightarrow$$
$$\frac{L^l}{4\gamma}[A^l - aw^l]^2 - f_I > \frac{L^l}{4\gamma}[A^l - a\tau_{kl}w^k]^2 - f_X \Longleftrightarrow$$
$$[A^l - aw^l]^2 - [A^l - a\tau w^k]^2 > m_I^{l2} - m_X^{l2}$$
$$z_{kl}a^2 - 2A^l a + \eta_{kl} < 0$$

with

$$z_{kl} = \tau w^k + w^l$$

and

$$\eta_{kl} = \frac{m_I^{l2} - m_X^{l2}}{\tau w^k - w^l}$$

We assume $\omega_{kl} = \tau w^k - w^l > 0$. Under the assumption that $A^{l2} > z_{kl}\eta_{kl}$ this polynomial expression has two solutions :

$$\widetilde{a}^1_{kl} = \frac{A^l + \sqrt{A^{l2} - z_{kl}\eta_{kl}}}{z_{kl}}$$
$$\widetilde{a}^2_{kl} = \frac{A^l - \sqrt{A^{l2} - z_{kl}\eta_{kl}}}{z_{kl}}$$

Firms with productivity in between the two thresholds prefer being engaged in FDI. Note that condition $A^{l2} > z_{kl}\eta_{kl}$ is equivalent to:

$$L^l > \frac{4\gamma z_{kl}}{A^{l2}\omega}(f_I - f_X)$$

Thus this condition holds for sufficient large countries.

We now focus on the relationship between the two thresholds and market size L^l.

Note that

$$\frac{\delta m_I^l}{\delta L^l} = -\frac{m_I^l}{2L^l}$$

and

$$\frac{\delta \eta_{kl}}{\delta L^l} = -\frac{\eta_{kl}}{L^l}$$

hence

$$\frac{\delta \widetilde{a}^1_{kl}}{\delta L^l} = \frac{1}{2z_{kl}}(A^{l2} - z_{kl}\eta_{kl})^{-\frac{1}{2}}(-z_{kl}\frac{\delta \eta_{kl}}{\delta L^l}) = \frac{(A^{l2} - z_{kl}\eta_{kl})^{-\frac{1}{2}}}{2}\frac{\eta_{kl}}{L^l}$$
$$\frac{\delta \widetilde{a}^2_{kl}}{\delta L^l} = -\frac{1}{2z_{kl}}(A^{l2} - z_{kl}\eta_{kl})^{-\frac{1}{2}}(-z_{kl}\frac{\delta \eta_{kl}}{\delta L^l}) = -\frac{(A^{l2} - z_{kl}\eta_{kl})^{-\frac{1}{2}}}{2}\frac{\eta_{kl}}{L^l}$$

Thus, we have:

$$\frac{\delta 1/\widetilde{a}^1_{kl}}{\delta L^l} < 0$$
$$\frac{\delta 1/\widetilde{a}^2_{kl}}{\delta L^l} > 0$$

The larger the market size L^l, the wider the range between the two cutoffs.

6.2 Number of active firms and available varieties

We suppose that country k is endowed with a mass of N_E^k firms. There is a fixed cost of entering denoted f_E. Once the firm has paid this sunk cost, it learns about its individual productivity a and decides whether to produce or not. Free entry ensures that expected gains equal the sunk entry cost. Expected gains are the sum of domestic profits, exporting profits and investing profits in other countries:

$$\int_o^{c_k^{*D}} \pi_k^D(a)dG(a) + \sum_{l\in K}\int_o^{c_{kl}^{*X}(c_l^{*D})} \pi_{kl}^X(a)dG(a) + \sum_{l\in K}\int_o^{c_{kl}^{*I}(c_l^{*D})} \pi_{kl}^I(a)dG(a) = f_E$$

This condition holds for each country k. Thus, we have K conditions that define together the K cutoff c_k^{*D} for $k \in \{1...K\}$. Equations (2.15) and (2.22) defined all cutoffs c_{kl}^{*X} and c_{kl}^{*I} for each k and l.

The number of active firms of country k is $n_k^D = N_E^k G(a_k^{*D})$, and total number of varieties exported and provided by FDI from country k to foreign countries are respectively :

$$n_k^X = \sum_{j\in K} n_{kj}^X = \sum_{j\in K} N_E^k G(a_{kj}^{*X})$$

$$n_k^I = \sum_{j\in K} n_{kj}^I = \sum_{j\in K} N_E^k G(a_{kj}^{*I})$$

The number of varieties available in market k is the sum of active domestic firms, foreign export decisions and foreign invest decisions from other countries into country k:

$$N^k = n_k^D + \sum_{j\in K} n_{jk}^X + \sum_{j\in K} n_{jk}^I$$

The condition on price maximum $A^k = p(c_k^{*D})$ gives, from (2.3):

$$N^k = \frac{2\gamma}{\eta}\frac{\alpha - (c_k^{*D} + m_k^D)}{c_k^{*D} + m_k^D - \overline{c}^k}$$

with

$$\overline{c}^k = [\int_0^{c_k^{*D}} cdG(c)]/G(c_k^{*D})$$

is the average costs of surviving firms. This result comes from average price in country k:

$$\overline{p}^k = \frac{1}{G(c_k^D)}\int_0^{c_k^{*D}} p(c^k)dG(c^k) = \frac{c_k^{*D} + m_D^k}{\overline{c}^k}$$

This result is similar to Melitz and Ottaviano (2003) without fixed costs and two countries.

6.3 Variables

For each of the 33 258 manufacturing firms present in 2002, we use BIC-BRN administrative data set from 1993 to 2002. Variables are constructed following Mairesse and Desplatz (2003).

- Output is measured by value added deflated by the price index of value added from National Counts at the two digits level.

- Capital stock is gross tangible fixed assets at the beginning of the year deflated by the investment price index available from National Counts. We choose to use capital stock at the beginning of the year to be consistent with Olley Pakes method. However using capital stock at the end of the year does not change significantly the results.
- Labor costs equal total employees pay plus social charges, deflated by the price index of value added from National Counts in order to have real wage costs.

6.4 Olley Pakes method

We use a simplified version of the Olley Pakes method that does not take into account selection bias. Profits are function of two distinct state variables, capital and productivity, but only productivity is not observed. This is the first strong assumption made by the authors. The implementation will use information on capital to learn more about productivity. Thus profits of firm i year t can be written as function of state variables:

$$\Pi_{it} = f(k_{it}, \omega_{it}) \tag{6.1}$$

with ω_{it} denoting TFP and k_{it} capital stock of firm i year t. Capital accumulation is given by $k_{t+1} = (1-\delta)k_t + i_t$ with i_t denoting investment and δ fixed depreciation rate. Productivity evolves over time according to a Markov process. The Bellman equation for an incumbent firm can be written as :

$$V_t(k_t, \omega_t) = \max\{\Phi, \sup_{i_t}\{\pi_t(k_t, \omega_t) - c(i_t)\} + \beta E[V_{t+1}(k_{t+1}, \omega_{t+1}|J_t)]\} \tag{6.2}$$

where J_t stands for available information year t, Φ the sell-off value, and $c(i_t)$ is the cost of investment. The investment demand equation is $i_t = i_t(k_t, \omega_t)$.
We assume a Cobb Douglas production function, with each variable written in log:

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \omega_{it} + \eta_{it} \tag{6.3}$$

where y_{it} is log value added from firm i year t, k_{it} the log of its capital inputs, l_{it} the log of its labor inputs, ω_{it} its productivity and η_{it} measurement error. Both ω_{it} and η_{it} are unobserved, but ω_{it} is a state variable. Provided $i_t > 0$, this investment demand function can be inverted:

$$\omega_{it} = h_t(i_t, k_t) \tag{6.4}$$

This equation rests on two assumptions : first ω_{it} is the only unobserved state firm specific variable. Second, investment is an increasing function of productivity. The first stage of the estimation procedure is then :

$$y_{it} = \beta_l l_{it} + \phi(k_{it}, i_{it}) + \eta_{it} \tag{6.5}$$

where

$$\phi(k_{it}, i_{it}) = \beta_0 + \beta_k k_{it} + h_t(i_t, k_t) \tag{6.6}$$

This semiparametric regression identifies β_l but not β_k. We use a three order polynomial in capital and investment for $\phi(k_{it}, i_{it})$. In the second stage of the procedure, we use the labor coefficient from the first stage for the period $t+1$:

$$y_{it+1} - \hat{\beta}_l l_{it+1} = \beta_k k_{it+1} + \omega_{it+1} + \eta_{it+1} \tag{6.7}$$

We define ξ_{it+1} as the innovation in ω_{it+1}:

$$\xi_{it+1} = \omega_{it+1} - E[\omega_{it+1}|\omega_{it}] \tag{6.8}$$

Productivity in period $t+1$ can then be decomposed into its innovation and a function of ω_{it} :

$$\omega_{it+1} = g(\omega_{it}) + \xi_{it+1} \tag{6.9}$$

$$\omega_{it+1} = g(\phi(k_{it}, i_{it}) - \beta_0 - \beta_k k_{it}) + \xi_{it+1} \tag{6.10}$$

The last equality comes from equation (6.6). Substitution in equation (6.7) gives the second step of the estimation procedure:

$$y_{it+1} - \hat{\beta}_l l_{it+1} = \beta_k k_{it+1} + g(\hat{\phi}(k_{it}, i_{it}) - \hat{\beta}_0 - \beta_k k_{it}) + \xi_{it+1} + \eta_{it+1} \tag{6.11}$$

We use a nonlinear regression for this second step because the capital coefficient enters in this last equation two times for period t and period $t+1$. Labor and capital estimates enable us to calculate the firm and time specific (log) productivity:

$$\omega_{it} = y_{it} - (\hat{\beta}_l l_{it} + \hat{\beta}_k k_{it}) \tag{6.12}$$

In order to obtain a productivity index with useful properties such as transitivity and insensitivity to units of measurement, we compare firm i's productivity in period t to the mean firm in the industry for a base year r. This methodology was used in several studies on trade and firm heterogeneity such as Aw, Chen and Roberts(1996) and Pavcnik (2002):

$$\tilde{\omega}_{it} = \omega_{it} - \omega_r \tag{6.13}$$

with

$$\omega_r = \bar{y}_{ir} - (\hat{\beta}_l \bar{l}_{ir} + \hat{\beta}_k \bar{k}_{ir}) \tag{6.14}$$

We use in our empirical section this productivity index $\tilde{\omega}_{it}$. Estimates and mean reference firm are defined for each two digits sectors. We retain year 1993 as our reference year for each sector.

Table 5: Probit with market size (Absorption)

	Dependent Variable: EXPORT vs FDI					
Model :	Apparent labor productivity			TFP		
ln distance	-0.12^a	-0.12^a	-0.13^a	-0.13^a	-0.13^a	-0.13^a
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
tariff	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
common language	-0.13^c	-0.13	-0.13	-0.15^c	-0.15^c	-0.10
	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
ex colonial relationship	0.44^a	0.43^a	0.44^a	0.46^a	0.47^a	0.41^a
	(0.06)	(0.06)	(0.07)	(0.06)	(0.07)	(0.07)
common border	0.32^a	0.31^a	0.32^a	0.32^a	0.32^a	0.31^a
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
ln French wages	-0.20	-0.19	-0.19	-0.13	-0.15	-0.13
	(0.12)	(0.12)	(0.13)	(0.13)	(0.13)	(0.14)
ln GDP per capita	-0.11^a	-0.10^a	-0.11^a	-0.11^a	-0.13^a	-0.11^a
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
ln capital	0.06^a	0.06^a	0.06^a	0.06^c	0.06^c	0.06^c
	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
ln absorption	0.14^a	0.13^a	0.14^c	0.13^a	0.16^a	0.07
	(0.02)	(0.02)	(0.07)	(0.02)	(0.03)	(0.07)
ln labor productivity	0.09^b	0.26	0.15			
	(0.04)	(0.24)	(0.22)			
(ln labor productivity)*(ln absorption)		-0.01	0.00			
		(0.01)	(0.01)			
(ln absorption)^2			0.00			0.00
			(0.00)			(0.00)
(ln labor productivity)^2			0.01			
			(0.01)			
ln TFP				0.00	-0.12	-0.18
				(0.04)	(0.10)	(0.11)
(ln TFP)*(ln absorption)					0.01	0.01^b
					(0.01)	(0.01)
(ln TFP)^2						0.01
						(0.01)
R^2	0.18	0.18	0.19	0.17	0.17	0.18
N	12800	12800	12800	12852	12852	12852

Note: Standard errors in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels.

Table 6: Market Potential Estimates with Export Productivity Threshold

Model :	Dependent Variable: EXPORT vs FDI
common language	0.07^a
	(0.58)
ln distance	0.01^a
	(0.06)
ex colonial relationship	0.55^a
	(0.35)
R^2	0.972
N	3205

Note: Standard errors in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels.

Table 7: Top 10 of Market Potential

Rank	Country
1	Italy
2	Germany
3	Spain
4	Switzerland
5	Great Britain
6	Netherlands
7	China
8	Belgium
9	Norway
10	Japan

Source : Estimates of market potential

Table 8: Probability of investing with cutoff market potential

	Dependent Variable: EXPORT vs FDI					
Model :	(1)	(2)	(3)	(4)	(5)	(6)
tariff	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
common border	0.17^a	0.17^a	0.07^c	0.17^a	0.17^a	0.08^b
	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)	(0.04)
ln French wages	-0.11^c	-0.11^b	-0.09^c	-0.10	-0.08	-0.06
	(0.05)	(0.05)	(0.05)	(0.06)	(0.06)	(0.06)
ln GDP per capita	-0.11^a	-0.11^a	-0.10^a	-0.11^a	-0.09^a	-0.07^a
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
ln capital	0.04^a	0.04^a	0.05^a	0.04	0.04	0.04
	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
ln cutoff market potential	0.69^a	0.70^a	0.12^c	0.69^a	0.34^a	-0.12
	(0.05)	(0.05)	(0.07)	(0.05)	(0.10)	(0.10)
ln labor productivity	0.07^c	0.03	-0.03			
	(0.03)	(0.12)	(0.08)			
(ln labor productivity)*(ln cutoff market potential)		0.02	0.04			
		(0.05)	(0.04)			
(ln labor productivity)^2			0.02^c			
			(0.01)			
(ln cutoff market potential)^2			0.19^a			0.17^a
			(0.03)			(0.03)
ln TFP				-0.01	0.15^b	0.20^a
				(0.04)	(0.06)	(0.05)
(ln TFP)*(ln cutoff market potential)					-0.08^a	-0.07^a
					(0.03)	(0.02)
(ln TFP)^2						0.01^b
						(0.01)
R^2	0.18	0.18	0.19	0.17	0.17	0.18
N	20270	20270	20270	20358	20358	20358

Note: Standard errors in parentheses with ^{a}, ^{b} and ^{c} respectively denoting significance at the 1%, 5% and 10% levels.