NOTES D'ÉTUDES

ET DE RECHERCHE

TOTAL FACTOR PRODUCTIVITY AND

THE DECISION TO SERVE FOREIGN MARKETS:

FIRM LEVEL EVIDENCE FROM FRANCE

Delphine Irac

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Firm level evidence from France

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Abstract

This paper examines productivity differences between firms doing foreign direct investment (FDI) and domestic firms on a sample of 28,133 continuing French firms over the period 1996-2002. The main contribution of this paper is to scrutinize the links between the different modes of globalization (exporting vs. setting up an affiliate overseas) and address the question of causality between productivity and global expansion. Comparing domestic firms and extra-firm exporters of goods, we find that pre-entry selection is more important than post-market-entry effects. Pre-entry boosts to productivity are interpreted as a reflection of sunk cost to exporting in our framework while the absence of post-entry productivity effects is interpreted as an absence of learning effects associated with exporting. This result does not seem to fully hold for exports of services, which we consider as a partial evidence of foreign knowledge spillovers at work in the exports of services; more in-depth investigation would be probably fruitful to identify the dynamics of the diffusion process.

Keywords: international trade, productivity, learning, spillover, self-selection

Résumé

Ce papier examine les différences de productivité entre des entreprises faisant des investissements directs étrangers (IDE), des entreprises exportatrices et des entreprises domestiques sur un échantillon de 28,133 entreprises françaises pérennes sur la période 1996-2002. En comparant les entreprises domestiques et les entreprises faisant des exportations de biens extra-groupe, nous observons que les effets productivité pré-entrée sont plus importants que les effets post-entrée. Alors que ceux-là sont interprétés comme un indice d'un coût fixe et d'une self-selection des entreprises, l'absence de ces derniers effets est interprétée comme une absence d'effets de type *learning* ou *spillover*. En revanche, notre article montre que ce résultat ne semble pas entièrement tenir pour les exportations de services. Nous interprétons ce résultat comme une évidence partielle d'effets d'apprentissage/diffusion dans les exportations de services. Une analyse plus approfondie permettrait d'identifier la dynamique du processus de diffusion.

JEL classification: F1, O4

Mots clefs: exportations, productivité, learning, spillover, self-selection

Non technical summary

This paper examines productivity differences between firms doing foreign direct investment (FDI) and domestic firms on a sample of 28,133 continuing French firms over the period 1996-2002. We first show that the ranking in size and productivity between domestic firms, exporters and firms with FDI holds for different measures of these variables, which is in line with several studies on various countries. The paper concentrates on two types of mechanisms leading to productivity differentials. First, most performing firms self-select into globalization because only this type of firms can absorb the sunk costs of starting exports or FDI. Second, firms with access to foreign markets through foreign affiliates and/or exports may have better access to new and improved foreign technology. Global firms should be more likely to benefit from international technological spillovers.

The main contribution of this paper is to scrutinize the links between the different modes of globalization (exporting vs. setting up an affiliate overseas) and address the question of causality between productivity and global expansion. The content of our dataset allows concentrating on extra-firm trade only, which constitutes an original feature of this paper. Another contribution of this paper is to pay special attention to the exports of services and to investigate whether the main empirical findings for exports of goods extend to services. Comparing domestic firms and exporters, we find that pre-entry selection is more important than post-market-entry effects. Pre-entry boosts to productivity are interpreted as a reflection of sunk cost to exporting in our framework while the absence of post-entry productivity effects is interpreted as an absence of learning effects associated with exporting. Moreover an original finding of our paper is to show that this result does not seem to fully hold for exports of services. Our work evidences that firms starting exporting services are not necessarily more productive prior to entry while serving foreign markets induces productivity boosts one and two years after the entry. We interpret this result as a partial evidence of foreign knowledge spillovers at work in the exports of services; more in-depth investigation would be probably fruitful to identify the dynamics of the diffusion process.

Résumé non technique

Ce papier examine les différences de productivité entre des entreprises faisant des investissements directs étrangers (IDE), des entreprises exportatrices et des entreprises domestiques sur un échantillon de 28,133 entreprises françaises pérennes sur la période 1996-2002. Nous montrons d'abord que le classement sur la taille et la productivité entre les entreprises domestiques, les exportatrices et les entreprises avec IDE est validé pour des mesures différentes de ces variables, ce qui est conforme aux résultats de différentes études antérieures sur des pays variés. Le papier se concentre sur deux types de mécanismes menant aux différentiels de productivité. D'abord, la plupart des entreprises s'auto-sélectionnent dans la globalisation en raison des coûts fixes d'entrée dans les exportations ou FDI. Deuxièmement, les sociétés ayant accès aux marchés étrangers via des filiales étrangères et/ou des marchés d'exportations bénéficient potentiellement d'une diffusion technologique (*spillover*) ou d'un apprentissage (*learning*) liés à l'accès à ces marchés.

La contribution principale de ce papier est d'analyser les liens entre les différents modes de globalisation (exportation vs. installation d'une filiale à l'étranger) et de traiter la question de la causalité entre la productivité et la globalisation. Nos données permettent de se concentrer sur le commerce extra-firme seulement, ce qui constitue une originalité de ce travail. Une autre contribution est de prêter une attention particulière aux exportations de services et d'examiner si les résultats empiriques principaux relatifs aux exportations de marchandises s'étendent aux services. En comparant les entreprises domestiques et les exportatrices de notre échantillon, nous constatons que les effets productivité pré-entrée sont plus importants que les effets post-entrée. Alors que ceux-là sont interprétés comme un indice d'un coût fixe, l'absence de ces derniers effets est interprétée comme une absence d'effets *learning/spillover*. En revanche, notre article montre que ce résultat ne semble pas entièrement tenir pour les exportations de services. Nous interprétons ce résultat comme une évidence partielle d'effets de type apprentissage/diffusion dans les exportations de services. Une analyse plus approfondie permettrait d'identifier la dynamique du processus de diffusion.

I. Introduction

This paper examines productivity differences between firms doing foreign direct investment (FDI), exporters – referred to hereafter as "global firms" - and domestic firms on a sample of 28,133 continuing French firms over the period 1996-2002. As evidenced in table 2, foreign investors' median size is bigger than exporters' and exporters' median size bigger than domestic firms'. This ranking holds whether size is measured with the number of employees, value added, total wage bill or equipment and is in line with several studies (see Bernard, Eaton, Jensen and Kortum (2003) hereafter BEJK (2003))[2]. Differences in output across these three groups of firms can be accounted for by two possible explanations[3]. First firms with FDI and exporters might have greater access to certain inputs (foreign inputs for instance). Second, given equal access to inputs, firms with FDI and exporters may be more productive. Our paper will concentrate on this second potential source of differences in output, with two types of mechanisms leading to productivity differentials. First, most performing firms self-select into globalization because only this type of firms can absorb the sunk costs of starting exports or FDI. Second, firms with access to foreign markets through foreign affiliates and/or exports may have better access to new and improved foreign technology. Global firms should be more likely to benefit from international technological spillovers.

The contributions of this paper are treble. Over the last years, it seems that the focus of international economists has shifted away from countries and

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[2] We can notice that service exporting firms are way bigger than goods exporting ones. This feature is partially attributable to a sectoral effect with most firms being in transports and only 9% in retail trade.

[3] Aw and Hwang (1995) develop an empirical model to distinguish the roles of input-level differences from productivity differences.

industries to firms and individuals. New theories have departed from a representative firms setting *a la* Krugman to explicitly introduce firm level heterogeneity. Empirically, this strand of research was boosted by the growing access to micro-level datasets. A first motivation of our work relies on the starting idea that it seems important to exploit recent existing sources, and especially Balance of Paiement (BoP) statistics, for France in order to check whether the standard patterns of international firm productivity hold for France. A distinguishing characteristic of BoP sources is that they include exports of goods and services separately, as well as FDI, which very few databases give. The dataset displays panel dimension (1996-2002) and contains information about exports but also FDI, together with a wide sample of firms' characteristics. The second contribution of this paper is to scrutinize the links between the different modes of globalization (exporting vs. setting up an affiliate overseas) and address the question of causality between productivity and global expansion: does performance beget exporting/investing abroad or does exporting/investing abroad beget performance? Our analysis contributes to the literature investigating the exports vs FDI decision with a focus on the interaction with productivity differentials. One major drawback of the various works exploring the decision to export is that no distinction is made between extra-firm and intra-firm exports. One nice feature of our dataset is to identify both FDI flows and export flows so that we can make sure that an export flow corresponds to extra-firm trade whenever no FDI flow is observed towards the same destination. By so doing, we are able to concentrate on extra-firm trade only which constitutes an original feature of this paper.

The third contribution of this paper is to pay special attention to the exports of services and to investigate whether the main empirical findings for exports of goods extend to services.

The findings of the paper can be summarized as follow. In line with BEJK (2003), we provide evidence that exporters' distribution of various measures of size and productivity is a "shift to the right of non-exporters distribution" and we extend this result to firms with FDI. Comparing domestic firms and exporters, we find that pre-entry selection is more important than post-market-entry effects. Pre-entry boosts to productivity are interpreted as a reflection of sunk cost to exporting in our framework while the absence of post-entry productivity effects is interpreted as an absence of learning effects associated with exporting. These findings confirm what have already been evidenced for many countries (eg Bernard and Jensen 2004, Clerides and Tybout 1997). Moreover an original finding of our paper is to show that this result does not hold for exports of services. Our work evidences that firms starting exporting services are not necessarily more productive prior to entry while serving foreign markets induces productivity boosts one and two years after the entry. We interpret this result as a piece of evidence of foreign knowledge spillovers at work in the exports of services; more in-depth investigation would be probably fruitful to identify the dynamics of the diffusion process.

II. The model

Generally, empirical evidence tends to point to a superior productivity of exporting firms compared to domestic ones. Two main frameworks can be put

forward to explain this general finding. First, what are commonly called "self-selection models" include within sectoral heterogeneity in size and productivity, yielding that the most productive firms engage in foreign trade. These models encompass two alternative approaches. We will intensively exploit Melitz (2003)'s model featuring fixed transport costs of exporting and heterogeneous plants to interpret the empirical results we obtain. But models of Bertrand competition in the spirit of BEJK (2003) also account for self-selection by showing that "more efficient producers are more likely to beat out rivals" and thus export because they charge lower prices. These conclusions are also valid for the US (Bernard and Jensen 2004) and Taiwan (Aw, Chung and Roberts 2000). Aitken et alii (1997) find that wages[4] are positively related to the decision to export. Roberts and Tybout (1997) get the same results with an additional effect of plant age.

According to an alternative framework, the key mechanism relies on international technological spillovers. We will use the theoretical model of export participation with learning effects developed by Clerides, Lach and Tybout (1998) as our benchmark model to account for these effects. Their model features monopolistic competition and endogenous past export status as cost shifters. They test the presence of shift in the stochastic cost process when a firm breaks into the foreign market. They find that relatively efficient firms become exporters but firms' unit costs are not affected by previous export market participation.

On the FDI side, a superior productivity of FDI firms relative to exporting ones is shown by selection model (HMY 2004, Head and Ries 2003). HMY (2004) develop a model of firms' choice between exports and horizontal FDI. Least productive firms serve only domestic markets, more productive firms serve both domestic

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[4]   as well as plant size and foreign ownerships

and foreign markets through exports and the most efficient firms serve foreign markets through foreign affiliates. They provide empirical evidence supporting their predicted ranking of firms' productivity but provide no insights about the direction of causality. Head and Ries (2003) generalize the results of HMY (2004) by introducing factor costs heterogeneity in their model. They show that when overseas production is situated in low cost countries, the ranking between FDI firms and exporting ones does not necessarily hold.

Theoretical works on outward FDI generated technological spillovers are relatively scarce whereas empirical literature is rich and burgeoning. Using patent citations data, Branstetter (2006) provides an "empirical framework to measure the impact of FDI in the US by a group of Japanese manufacturing firms on knowledge flows from American firms to these investing Japanese firms". Within this setting, he shows evidence of knowledge spillovers in both directions.

The demand function stems from a monopolistic competition framework and can be expressed as: $q = zp^{-\sigma}$ with q=quantity sold, p=price and z= demand shifter. The supply side is described by the following profit function: $\pi = pq - C(\varphi)$. With total cost, $C(\varphi)$, being equal to fixed cost plus variable costs : $C(\varphi) = f + q(\varphi)/\varphi$ for domestic firms. φ represents productivity. Exporting firms face an iceberg cost τ as well as a higher fixed cost (f_x): $C(\varphi) = f_x + \tau q(\varphi)/\varphi$. The cost function for firms doing FDI is in the spirit of a standard proximity-concentration trade-off model: $C(\varphi) = f_I + q(\varphi)/\varphi$ with $f_I > f_x > f$. Firms charge the price $p = 1/\rho\varphi$ when purely domestic or doing FDI, whereas they charge: $p = \tau/\rho\varphi$ when exporting.

Hence revenues are given by the three equations:

Revenues of domestic firms: $r_d(\varphi) = pq = zp^{-\sigma+1}$

Revenues of exporting firms: $r_x(\varphi) = \tau^{1-\sigma} r_d(\varphi)$

Revenues of firms investing abroad : $r_I(\varphi) = r_d(\varphi)$

This gives three profit functions:

Instantaneous profit of a domestic firm : $\pi_d(\varphi) = r_d(\varphi)/\sigma - f$

Instantaneous profit of a exporting firm : $\pi_x(\varphi) = \tau^{1-\sigma} r_d(\varphi)/\sigma - f_x$

Instantaneous profit of a firm investing abroad: $\pi_I(\varphi) = r_d(\varphi)/\sigma - f_I$

In order to allow the model to potentially account for learning effect, we assume that firm productivity can be affected by the firm's exporting/investing decisions. More specifically, we assume that a firm has her productivity level φ governed by some transition matrix P₀ if the firm does not export. If the firm does export the transition matrix is P₁, which stochastically dominates P₀ whereas the productivity of a firm doing FDI is governed by P₂, which stochastically dominates P₀ and P₁. If no learning effects are at work, P₀ governs productivity whether the firm is global or not.

We define $\delta_{I,t}$, $\delta_{x,t}$, $\delta_{D,t}$ as:

$\delta_{I,t} = 1$ if the firm invests abroad at time t, and 0 otherwise.

$\delta_{x,t} = 1$ if the firm exports without investing abroad at time t, and 0 otherwise.

$\delta_{D,t} = 1$ if the firm only operates on the domestic market.

The discounted value of profits is given by:

$$V_t(\varphi_t) = \underset{\{\delta_{dt+s},\delta_{xt+s},\delta_{it+s}\}_{s=0}^{+\infty}}{Max} E_t \sum_{s=0}^{\infty} (1-\delta)^s \left[\pi_x(\varphi_{t+s})\delta_{x,t+s} + \pi_d(\varphi_{t+s})\delta_{d,t+s} + \pi_I(\varphi_{t+s})\delta_{I,t+s}\right]$$

Under the assumption of no learning effect, the discounted value of firm is:

$V_i(\varphi) = \pi_i(\varphi)/\delta$ where subscript $i=d, x$ or I.

From these two equations, we can define two threshold:

$$\varphi_d* = \inf\{\varphi : V_d(\varphi) > 0\} \qquad r_d(\varphi_d*) = f\sigma$$
$$\varphi_x* = \inf\{\varphi : V_x(\varphi) > 0\} \quad \rightarrow \quad r_d(\varphi_x*) = f_x\sigma/\tau^{1-\sigma}$$
$$\varphi_I* = \inf\{\varphi : V_I(\varphi) > 0\} \qquad r_d(\varphi_I*) = f_I\sigma$$

And thus the different thresholds are related in the following way:

$$\begin{cases} \varphi_x* = \varphi_d* \tau(f_x/f)^{1/(\sigma-1)} \\ \varphi_I* = \varphi_d*(f_I/f)^{1/(\sigma-1)} \end{cases}$$

We have $\varphi_d* < \varphi_x*$ as long as $\tau^{\sigma-1}f_x > f$. Under this assumption, the model predicts that more productive firms within an industry self-select into the export market. Similarly, self selection takes place also for investing decision as long as $\tau^{\sigma-1}f_x > f_I$.

Clerides, Lach and Tybout (1998) give the simulated average cost trajectories with and without learning. Intuitively, without learning effect, most of the catch up process in productivity has occurred before the transition period. Whereas with learning effects a significant part of the catch up process can occur after the transition period since firms enjoy more positive productivity changes after entry. The following graph gives the average trajectories of entrants productivity, such as they are computed by Clerides, Lach and Tybout (1998). As they observe, "one distinguishing feature of the learning trajectories is that exporting firms exhibit ongoing cost reductions after initiating foreign sales. Only when learning effects are present, do firms continue to pull away from non-exporters after foreign market entry." Without learning effect, most entrants reach the threshold level (expressed in terms of costs in the graph) before the entry period whereas with learning effect entrants are likely to enjoy more positive productivity shocks after entry.

Figure 2a: Entrants
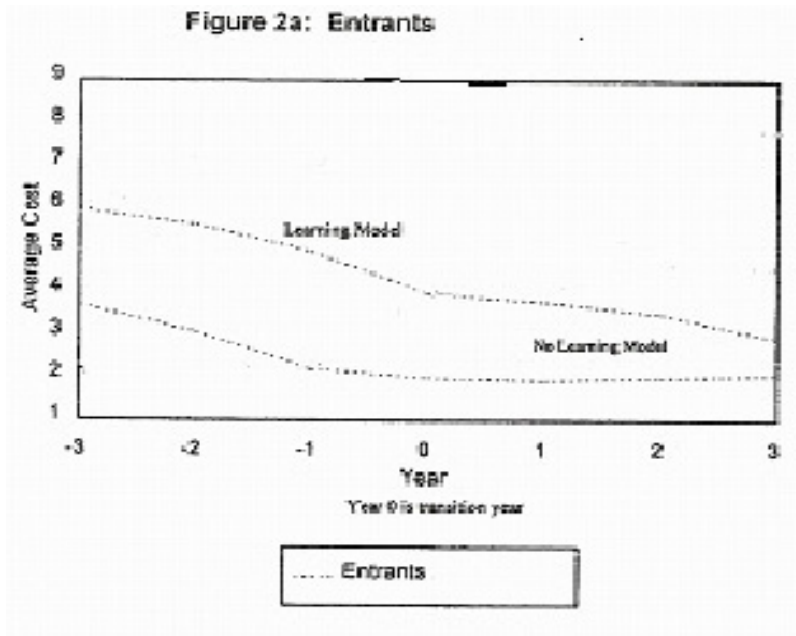
Source: Is "Learning-by-Exporting Important?" Clerides, Lach and Tybout, QJE (1998). Upper line: learning model; lower line: no learning model; x-axis: year (year 0= entry date); y-axis: average costs of entrants.

This result provides two alternative ways to test for learning effects. First under learning effect assumption, the productivity gap between domestic firms and entrants should continue increasing after the transition period and the gap between entrants and exporting firms should continue narrowing. This methodology is the same as in Delgado, Farinas and Ruano (2002). We test this assumption in tables 5, 7 and 9. Alternatively, the increase in productivity, φ, should be higher for entrants than for exporters since entrants are still converging towards exporters even after the transition period. Without learning effects, the catch-up process is done by the transition period and no productivity increase occurs afterwards. With learning by exporting, firms exhibit ongoing productivity increases after initiating foreign sales as a result to switch to a better transition matrix. We test this assumption in tables 6, 8 and 10.

III. Dataset and empirical strategy

The dataset we exploit in this study results from matching four different firm level sources. Information about parent companies (production, sales, number of employees, capital stock etc) comes from Fiben Database, which includes financial statements of 200,000 French firms. We have information about exports of goods and services and foreign direct investment of 120,000 French firms (BoP sources), with a breakdown by destination/origin countries. The dataset 'Liaisons financières' enables to identify the cross participation within the firms of our dataset. We are therefore able to work at a consolidated level, which we consider as the more appropriate level for carrying out our analysis. Systematic datacleansing is implemented at the consolidated level by taking out all firms such that: $|y_{it}-y_t|>4sd(y_{it})$, y_{it} being the variable of interest for firm i at time t , y_t the average of over time, sd stands for standard deviation. After consolidation and datacleaning, we are left with 28,133 firms.

Firm characteristics are drawn from the FIBEN database which is collected at the Banque de France. As we already detailed, the comparative advantages of our dataset relative to other existing studies are mainly (i) the length of the time period (1996-2002), which - as we saw - enables to address causality question, (ii) the inclusion of a large bulk of firm characteristics, which enables to properly compute firm level TFP, and (iii) information about exports of goods and services separately as well as FDI. The lack of individual firm information on output prices is a major problem in the micro-econometrics of production. Since firms's output are not directly observable, we assume that firm level prices are not fluctuating too much relative to the sectoral price index and that sales, deflated by a common sectoral index, are a good proxy for output. This is a standard

assumption that does not seem too strong. For instance Mairesse and Jaumandreu (2006) find that estimating revenue function or a production function makes very little difference for their results.

The dataset is divided into different sub-groups. For year 2002, we divide our set of firms between purely domestic firms (type D); exporting firms that are not doing FDI (X); service exporting firms that are not doing FDI (Xs) and firms that are both investing abroad and exporting (I)[5]. DDDXXXX stands for firms that remain domestics for the first three years of our time period and export over 1999-2002. This notation rule straightforwardly extends to the other sub-groups.

We have three main concerns in mind when devising our methodological framework. First we want to base our analysis on both graphical and statistical evidences, in order to check for possible outliers in the dataset. Second we think that a non parametric approach is better catered to the kind of data we are handling. Indeed, some subsets of our dataset are limited to a small amount of observations. Besides, a regression based approach, like the approach of Bernard and Jensen (2004) suffers from the standard problem that no firm level fixed effects can be controlled for, which might induce some strong biases in the exporter status coefficient. Third we want to provide confidence intervals around our graphical or statistical results. Kernel density estimation and Somer's D statistics satisfy these three goals. Kernel density estimation consists in a non parametric technics in which a known density function (the kernel) is averaged across the observed data points to create a smooth approximation. Given the relatively small numbers of observations for certain sub groups of firms we

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[5]   The dataset contains no firm doing FDI but no exports.

consider, we provide confidence intervals around the estimates to draw robust conclusions from the plots. For details about standard errors calculations, we can refer to the appendix. In order to formally test whether productivity distribution can be ordered across the different groups of firms, we also use a non parametric approach by calculating Somer's D statistics, which can be viewed as a refined version of a standard rank test.

IV. Results

First result: ranking in size and productivity according to exports/FDI status.

This result emerges from table 2 and graphs. Table 2 shows that median number of employees is 52% higher for exporters than domestic firms. The size differential reaches 77% when we look at value added, 70% concerning total wages and 142% concerning equipments. Comparing exporters and foreign investors, the gap is even more striking: firms with FDI have 289% more employees, earn 381% more value added, give 328% more wages and possess 401% more equipments. Strong evidence of a ranking in productivity from D to X and X to I type firms in 2002 is also noticeable (see graphs). Interestingly, the productivity advantage is lower for service exporters than for goods exporters, which constitute a first hint that sunk costs may not big that significant in serving service markets abroad.

Exporters of goods: Self-selection rather than spillover effects.

As evidenced in table 5, a randomly chosen domestic firm that enters the export of goods market in 1999 is, in 1996, 13% to 29% more likely to have higher *tfp* than a firm remaining on the domestic market over 1999-2002. The productivity advantage is stable over the sample period ([0.15%;0.31%] in 2002) and is not

significantly altered by serving foreign markets. Therefore 3 years prior to entry, future exporting firms have already a substantial performance advantage in *tfp* over domestic ones. In our analysis, the productivity differential is attributable to self-selection effects; firms increase their productivity prior to entry so that they might be profitable enough to absorb the sunk cost of exporting. In order to confirm the lack of evidence of spill-over effects, another way of testing the spill-over hypothesis is implemented. Learning-by-exporting/learning-by-investing abroad implies that following the year of entry the distribution of productivity increase for domestic firms is superior to that of entering firm (see Delgado, Farinas and Ruano 2002):

Distribution {Δ(productivity entering)} > Distribution {Δ(productivity non entering)}

during the years following entry.

Table 6 gives the results of the associated Somer's D statistics, which confirm the absence of compelling evidence of spill-over effects. Indeed, no ranking can be statistically significantly observed between the two distributions of productivity growth at any horizon. The Somer's D statistics is very low and even negative three years after the entry date (-0.004 in 2002). These results confirm the validity of the self-selection model for exports of goods sketched in the previous section and is consistent with what is found for several countries (US, Spain, Germany).

Exporters of services: spillover effects rather than self-selection.

A very different picture emerges when we focus on exporters of services only (see tables 9 and 10). Three years before entry, no productivity advantages are noticeable for firms starting exporting services (the ranking even appears in the

opposite direction in 1996). One year after entry (2000), the same pattern in the relative productivity distribution applies, whereas two years after entry the entering firms seem to have gain strong advantage in productivity. The approach in TFP growth confirms this finding (table 10). Entering firms show a significantly stronger increase in productivity than non entering firms. These results suggest that spillover effects are at work for the exporters of services[6].

V. Conclusion

This work relies on an original database, including BoP statistics, which enables to investigate questions that are rarely dealt with in the empirical literature on firm level decisions to serve foreign markets. First, thanks to data on FDI, we are able to concentrate on extra-firm trade only, which addresses a standard drawback of this kind of exercise. Second, this paper endeavours to clearly address the question of causality between TFP and the decision to serve foreign market. Its empirical approach is non parametrical in order to rely on few statistical assumptions and to deal with small subsets. Third, the main original finding of this paper is that self-selection model a la Melitz does not seem to fully apply when the analysis is extended to service markets for which the mechanism at work seems much more related to post entry learning effects. This conclusion puts the emphasis on the specificity of international trade in services, that dot seem to follow the same pattern as exports of goods and feature higher intensity

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[6] No clear-cut conclusion can be drawn for FDI firms. With table 12, we cannot accept the hypothesis of spillover effect but table 11 does not show significantly productivity advantage at any time horizon for investing firms. Beyond the fact that this absence of robust result might be attributable to the small number of entering firms (only 7 firms start FDI in 1999), another major issue surrounds the investigation. We suspect that TFP might be ill-measured for multinational firms. With our measure of TFP, we mainly capture TFP of the parent company since value added and intermediate consumptions are not given for the group and we have no indications about TFP of the foreign affiliates.

in knowledge spillovers. This paper only provides preliminary evidence. Conclusions about MNFs are more disappointing, with no clear-cut findings, probably due to the difficulty of measuring MNFs' TFP. Deeper empirical investigation would be fruitful especially to investigate how service exports articulate with FDI that are generally associated with these flows.

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Notations:

empl= number of employees

vacf= value added at factor costs

totalw= total wage bill

equip= equipment (net)

tfp= total factor productivity

alp= average labour productivity

w= per capita wages

Dn= domestic firms in year n

Xn= exporting firms in year n (goods and services)

Xsn= exporting firms in year n (services only)

In= investing abroad firms in year n

DDDDDDD= purely domestic firms; more generally each character (D/X/I) of the sequence indicates firm's status at the year the position of the character corresponds to.

Table 3.1 - Year 2002: Number of firms. Breakdown by X/FDI status and type of exports (goods/services)

	2002
Domestic firms	21416
Exporters (no FDI), *of which:*	6407
Exporters of goods	*6342*
Exporters of services(no FDI)	*8*
Exporters of service (FDI)	57
Foreign investors	310
Total	28133

Table 3.2 – Year 2002. Size and productivity, median.

	nb of employees	Value added	Wage bill	Equipment
D	19.00	798.00	628.00	26.00
X	29.00	1414.00	1065.00	63.00
Xs	357.00	22464.00	14891.00	2057.00
I	113.00	6809.00	4559.50	316.00
Total	20.00	904.00	697.00	31.00

	TFP	ALP	wage rate	
D	0.68	3.69	3.41	
X	0.94	3.85	3.53	
Xs	0.77	4.06	3.64	|
I	1.21	3.97	3.59	
Total	0.73	3.73	3.44	

Note: lines D/X/Xs/I represent respectively the sets of domestic firms, exporting firms, service exporting firms, and firms with FDI in 2002.

Table 3.3 - Sectoral breakdowns

	All firms	Exporting firms	Service exporting firms
Manufacture of food products, beverages and tobacco	4.95%	5.96%	2.27%
Manufacture of consumers goods	6.07%	8.76%	18.18%
Manufacture of motor vehicles	0.65%	1.01%	0.00%
Manufacture of capital goods	8.13%	12.37%	11.36%
Manufacture of intermediate goods	17.64%	28.72%	11.36%
Energy	0.11%	0.08%	2.27%
Construction	20.82%	6.70%	11.36%
Retail trade	32.47%	27.99%	9.09%
Transports	5.36%	4.91%	25.00%
Real estate activities	0.19%	0.19%	0.00%
Services to businesses	3.60%	3.32%	9.09%

Table 3.4 - Ranking in productivity. Somer's D.

Domestic vs. exporters (of goods and services)

	D stat.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Tfp |	.2656249	.0091528	29.02	0.000	.2476856	.2835641
alp |	.2668246	.0078276	34.09	0.000	.2514829	.2821664
w |	.2477927	.0077829	31.84	0.000	.2325386	.2630469

Nb of D= 21,416 ; nb of X=6,407

Domestic vs. exporters (of services only)

	D stat.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Tfp |	.1732082	.0894026	1.94	0.053	-.0020177	.348434
alp |	.5058793	.0611829	8.27	0.000	.3859629	.6257956
w |	.4958437	.0617957	8.02	0.000	.3747264	.6169611

Nb of D=21,416 ; nb of Xs=57

Exporters of goods and services vs. firms doing FDI

	D stat.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Tfp |	.1558401	.0384729	4.05	0.000	.0804346	.2312457
alp |	.1692066	.0327614	5.16	0.000	.1049954	.2334177
w |	.1437707	.0342831	4.19	0.000	.076577	.2109643

Nb of X=6,407; nb of FDI:310
Note: how to read table "A vs. B". The D stat. can be interpreted in the following way:
given randomly chosen firm of type A and firm of type B, the B firm is D% more likely to
have higher tfp than firm A. Col. 5 and 6 give the 95% confidence interval surrounding D
and col. 2,3,4 give respectively the standard error, the associated Z stat. and its p
value.

**Table 5 – Purely domestic firms (DDDDDDD) Domestic firms starting exporting
goods or services in 1999 (DDDXXXX). Somer's D. Productivity ranking.**

	D stat	Std. Err.	z	P>|z|	[95% Conf.	Interval]
1996 |	.2131031	.0406313	5.24	0.000	.1334673	.292739
1997 |	.2166145	.0399244	5.43	0.000	.1383641	.2948648
1998 |	.2216982	.0391842	5.66	0.000	.1448985	.2984979
1999 |	.2301448	.0384844	5.98	0.000	.1547168	.3055728
2000 |	.2218577	.0385162	5.76	0.000	.1463673	.2973481
2001 |	.2260409	.0401646	5.63	0.000	.1473198	.304762
2002 |	.2350418	.0422513	5.56	0.000	.1522308	.3178528

**Table 6 – Purely domestic firms (DDDDDDD) Domestic firms starting exporting
goods or services in 1999 (DDDXXXX). Somer's D. Productivity growth ranking.**

	D stat.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
2000	.0077875	.047268	0.16	0.869	-.0848561	.1004312
2001	.0084863	.0470815	0.18	0.857	-.0837917	.1007643
2002	-.004151	.0485694	-0.09	0.932	-.0993454	.0910433

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Table 7 – Purely domestic firms (DDDDDDD) Domestic firms starting exporting goods only in 1999 (DDDXXXX). Somer's D. Productivity ranking.

	D stat.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
1996	.2131031	.0406313	5.24	0.000	.1334673	.292739
1997	.2166145	.0399244	5.43	0.000	.1383641	.2948648
1998	.2216982	.0391842	5.66	0.000	.1448985	.2984979
1999	.2301448	.0384844	5.98	0.000	.1547168	.3055728
2000	.2218577	.0385162	5.76	0.000	.1463673	.2973481
2001	.2260409	.0401646	5.63	0.000	.1473198	.304762
2002	.2350418	.0422513	5.56	0.000	.1522308	.3178528

Table 8 – Purely domestic firms (DDDDDDD) Domestic firms starting exporting goods only in 1999 (DDDXXXX). Somer's D. Productivity growth ranking.

	D stat.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
2000	.0144669	.0470302	0.31	0.758	-.0777107	.1066445
2001	.0168766	.0469546	0.36	0.719	-.0751528	.108906
2002	-.0057617	.0484595	-0.12	0.905	-.1007406	.0892172

Table 9 – Purely domestic firms (DDDDDDD) Domestic firms starting exporting services only in 1999 (DDDXXXX). Somer's D. Productivity ranking.

	D stat.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
1996	-.0978166	.0067336	-14.53	0.000	-.1110142	-.0846191
1997	-.0093291	.0068643	-1.36	0.174	-.0227829	.0041248
1998	-.027668	.0069406	-3.99	0.000	-.0412713	-.0140646
1999	-.1229573	.0069631	-17.66	0.000	-.1366048	-.1093098
2000	-.046988	.007078	-6.64	0.000	-.0608605	-.0331154
2001	.0054181	.0071499	0.76	0.449	-.0085954	.0194316
2002	.0195648	.0072319	2.71	0.007	.0053905	.033739

Table 10 – Purely domestic firms (DDDDDDD) Domestic firms starting exporting services only in 1999 (DDDXXXX). Somer's D. Productivity growth ranking.

	D stat.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
2000	.331089	.0067397	49.13	0.000	.3178795	.3442985
2001	.2930407	.0068959	42.49	0.000	.2795249	.3065564
2002	.1097879	.007248	15.15	0.000	.095582	.1239937

Table 11 – Purely exporting firms (XXXXXXX) Domestic firms starting exporting services only in 1999 (XXXIIII). Somer's D. Productivity ranking.

	D stat.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
1996	.2821798	.2311744	1.22	0.222	-.1709138	.7352734
1997	.26123	.2361722	1.11	0.269	-.2016591	.7241191
1998	.2761391	.2409925	1.15	0.252	-.1961975	.7484756
1999	.2452927	.2307553	1.06	0.288	-.2069794	.6975649
2000	.2754964	.2372093	1.16	0.245	-.1894252	.7404181
2001	.2843648	.238331	1.19	0.233	-.1827555	.751485
2002	.2718977	.2284174	1.19	0.234	-.1757922	.7195876

Table 12 – Purely domestic firms (XXXXXXX) Domestic firms starting exporting goods only in 1999 (XXXIIII). Somer's D. Productivity growth ranking.
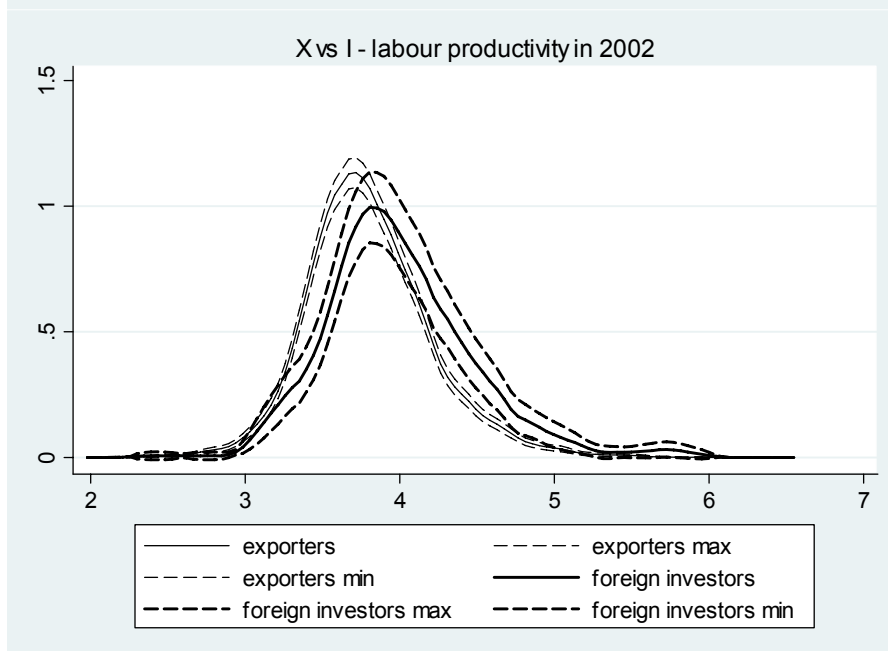
	D stat.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
2000	.0419467	.218501	0.19	0.848	-.3863073	.4702007
2001	-.1592028	.2180036	-0.73	0.465	-.586482	.2680763
2002	.0637389	.1770666	0.36	0.719	-.2833054	.4107831

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Average Labour Productivity : Kernel density estimation- All sectors
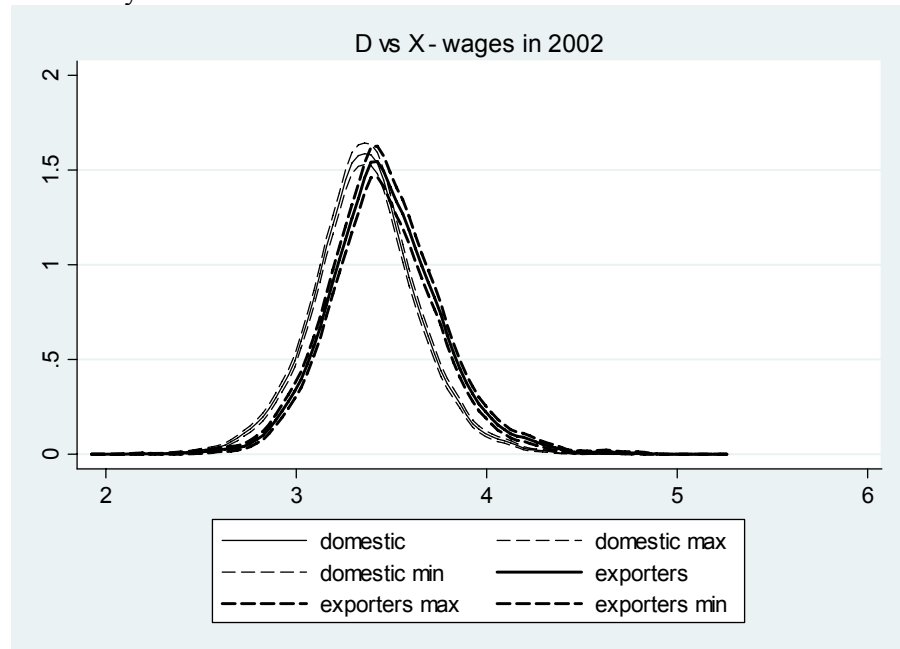
Domestic firms vs exporters

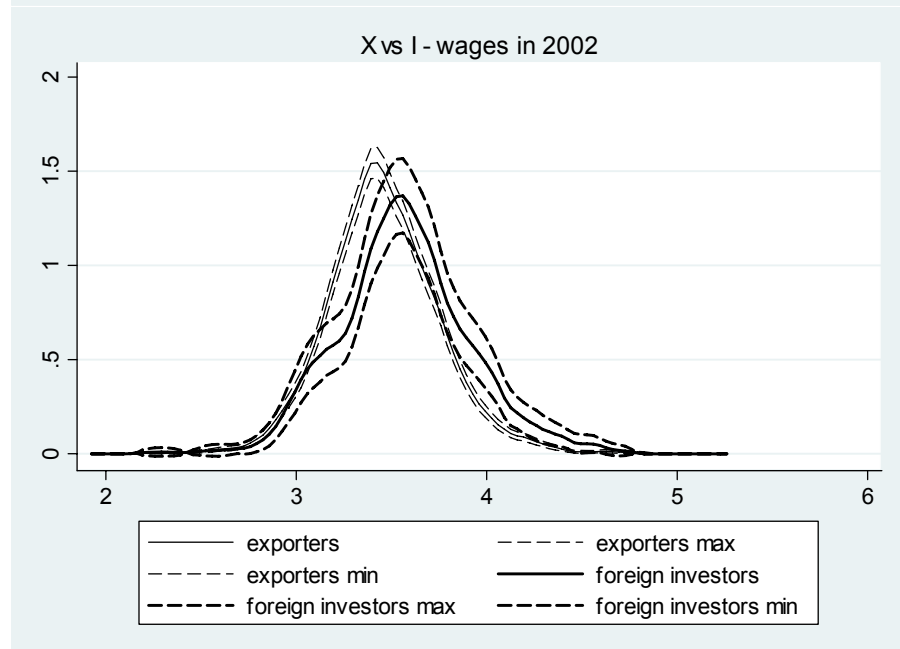D vs X - labour productivity in 2002

domestic	domestic max
domestic min	exporters
exporters max	exporters min

Exporters vs Foreign investors

X vs I - labour productivity in 2002

|	
exporters	exporters max
exporters min	foreign investors
foreign investors max	foreign investors min

See appendix for details of the computation of confidence intervals.

Wages per capita : Kernel density estimation. - All sectors

Domestic firms vs exporters

D vs X - wages in 2002

	domestic		domestic max
	domestic min		exporters
	exporters max		exporters min

Exporters vs Foreign investors

X vs I - wages in 2002

	exporters		exporters max
	exporters min		foreign investors
	foreign investors max		foreign investors min

See appendix for details of the computation of confidence intervals.

Total factor productivity : Kernel density estimation. All sectors
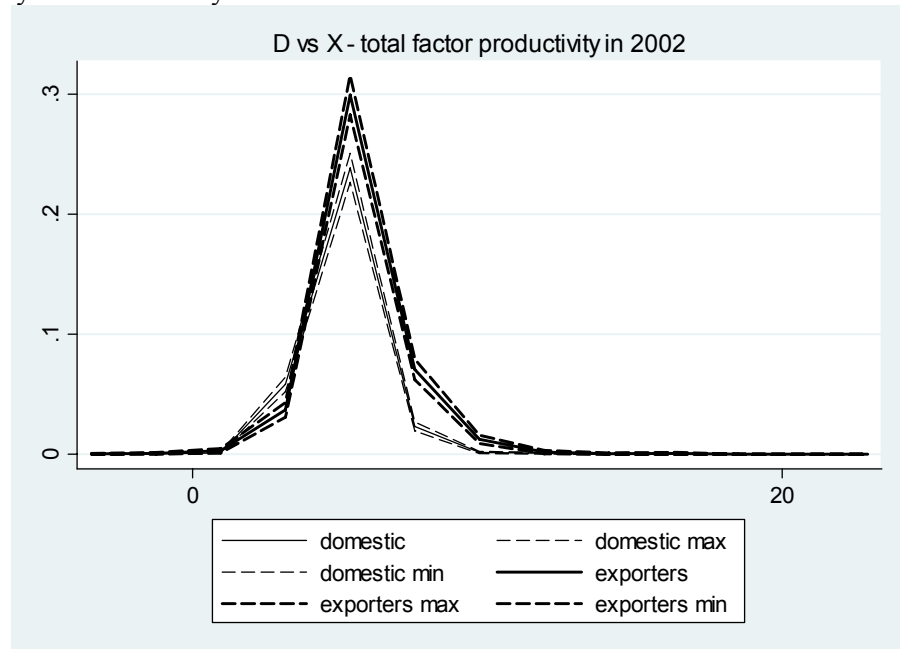
Domestic firms vs. exporters

D vs X - total factor productivity in 2002

Exporters vs. Foreign investors

X vs I - total factor productivity in 2002

See appendix for details of the computation of confidence intervals.

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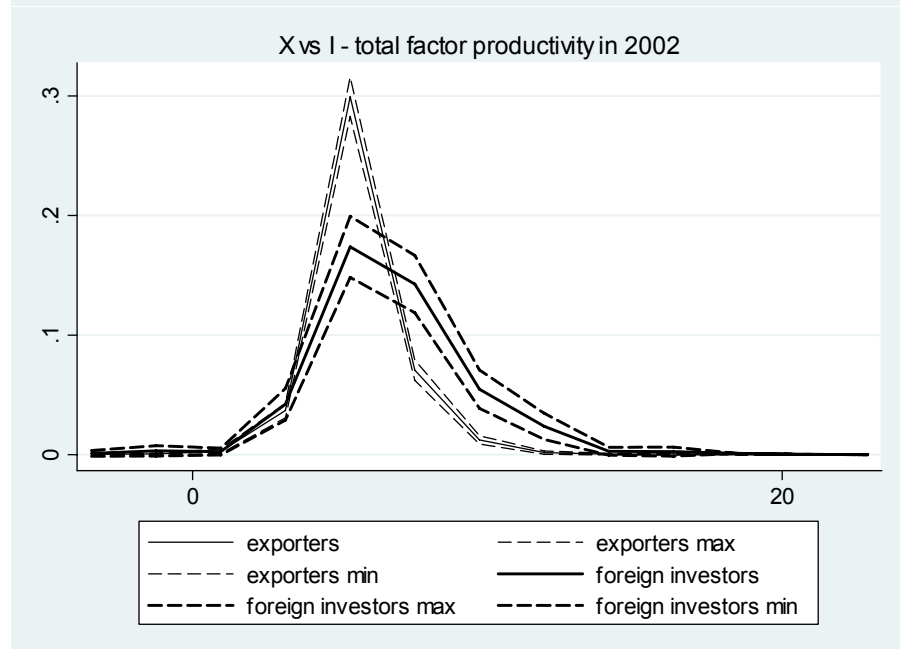
Appendix 2 – Somer's D

Somer's D statistics

Statisticians increasingly recommend confidence intervals in preference to P-values alone. The Somer's D is a rank-based parameter.

Given two variables *X* and *Y,* sampled jointly from a bivariate distribution, the population value of a Kendall's τ_a is defined as:

$\tau_{XY} = E[sign(X_1 - X_2)sign(Y_1 - Y_2)]$ where *(X₁,Y₁)* and *(X₂,Y₂)* are bivariate random variables sampled independently from the same population en *E[.]* denotes expectations.

The population Somer's D value is defined as:

$$D_{YX} = \frac{\tau_{XY}}{\tau_{XX}}$$

In this work X is a binary variable, X=1 or 0 and then D$_{YX}$ boils down to:

$$D_{YX} = \Pr(Y_1 \succ Y_0) - \Pr(Y_0 \succ Y_1)$$

With *Y₁* is randomly sampled from the population with *X=1* and *Y₀* is randomly sampled from the population with *X=0*. Given a randomly chosen *Y₁* corresponding to *X=1* and a randomly chosen Y₀ corresponding to *X=0, Y₁* is *D$_{YX}$* more likely to be higher than *Y₀* than to be lower.

Since: $\Pr(Y_0 \succ Y_1) = 1 - \Pr(Y_1 \succ Y_0)$ we have : $\Pr(Y_1 \succ Y_0) = \frac{D_{YX} + 1}{2}$

Appendix 3 – Confidence intervals for Kernel density estimation

Univariate Kernel density estimation

Let $X_1,\ldots, X_n$ be a sample from X, where X has the probability density function $f(x)$. $f(x)$ can be estimated as:

$$\hat{f}(x;h) = \frac{1}{n}\sum_{i=1}^{n}\frac{1}{h}K\left(\frac{x-X_i}{h}\right)$$

where $K(z)$ is a kernel function, he is the smoothing parameter (the kernel halfwidth or bandwidth).

The variance estimator is given by:

$$\overset{\wedge}{Var}\,\hat{f}(x;h) = \frac{1}{n}\left\{\frac{1}{n}\sum_{i=1}^{n}\frac{1}{h^2}K\left(\frac{x-X_i}{h}\right)^2 - \hat{f}(x;h)^2\right\}$$

It is therefore possible to construct pointwise confidence intervals:

$$\hat{f}(x;h) \pm t_{1-\alpha/2}(n)\sqrt{\overset{\wedge}{Var}\left\{\hat{f}(x;h)\right\}}$$

These confidence intervals have to be bias corrected:

$$\hat{f}(x;h) \pm t_{1-\alpha/2}(n)\sqrt{\overset{\wedge}{Var}\left\{\hat{f}(x;h_{US})\right\}}$$

With: $h_{US} = h\dfrac{n^{1/5}}{n^{\tau}}$ with τ being an undersmoothing parameter, inferior to $1/5$.

We take Epanechnikov Kernel function, namely:

$$K(z) = \begin{cases} \left.\dfrac{3}{4}\left(1-\dfrac{1}{5}z^2\right)\right/\sqrt{5} & \text{if } |z| \prec \sqrt{5} \\ 0 \text{ otherwise} \end{cases}$$

We use data-dependant bandwidth selection:

$\hat{h}_S = 1.159\delta_K\hat{\sigma}n^{-1/5}$ with σ is taken as the minimum of the standard deviation and the interquantile range of the observed data.

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