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Abstract

This paper provides evidence on the links between productivity and internationalisation choices for a large sample of both large and small-medium sized Italian firms. By using detailed qualitative and quantitative information we first identify those firms engaged in international activities through exports and/or horizontal FDIs. Following the empirical literature on firm heterogeneity we estimate different measures of Total Factor Productivity and we provide empirical support to the theoretical predictions that there is a productivity ranking among domestic firms, exporters, and FDI performers. By estimating a multinomial logit model, we also control for the effect of variables other than TFP such as size, innovative activity, age, ICT adoption, labour composition, and group membership. As these variables only partially capture the effect of productivity on the probability to engage in foreign markets, we find that the ranking is robust with respect to the inclusion of these additional firm-level characteristics.

JEL Classification: D24, F14, F23, C35
Keywords: FDI, Productivity, Export, Firm Heterogeneity, Multinomial Logit

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1 Introduction

A striking intra-industry heterogeneity in firms' international engagement exists. In fact, we observe - even within narrowly defined industries - that some firms serve only the domestic market, others also export into foreign countries, while others own production plants abroad.

This evidence is at odds with the theoretical literature on international trade developed up to the mid 90's, which assumed that whether and how firms enter foreign markets (through export and/or Foreign Direct Investments, FDI henceforth) is determined only by *industry* characteristics such as transport costs and trade barriers. Recent advances have filled the gap between the empirical evidence and the theory by highlighting how heterogeneity in productivity at the firm level is the key driver of internationalisation choices. A first strand of literature put forth the idea that only firms with an above average level of productivity are able to afford the fixed costs entailed by exporting (e.g. market research and set up of new distribution channels) whereas the least productive firms serve uniquely the domestic market. More recently, the productivity comparison has been extended by including a third group of firms, those with production facilities in foreign countries. The starting point is that production abroad, on the one hand, entails the fixed costs associated with the duplication of domestic plants but, on the other hand, allows the firm to save on transportation costs. As fixed costs are higher for setting up production facilities abroad than for exporting, the theory predicts the following ranking in productivity: FDI firms should outperform exporters, which in turn should outperform firms serving only the domestic market.

This ranking of productivity according to firms' internationalisation modes has been tested only by a limited number of papers, mostly because of the lack of suitable databases containing detailed information on both export and multinational activities. Overall, the empirical evidence tends to confirm the alleged ranking especially for the comparison between FDI and exporters. However, part of this literature suffers from the use of dataset biased towards large firms and therefore against finding significant productivity differences. Furthermore, theoretical predictions refer only to horizontal FDI (i.e. FDI which substitute export activities) and not to other kinds of FDI, such as vertical or unrelated ones, but empirical analyses often face awkward difficulties to properly identify

the type of activity performed abroad. Finally, the models assume an exogenous productivity advantage for firms serving foreign markets but fail to identify the sources of these advantages. In turn, this leaves the possibility that internationalised firms are not more productive *per se*, but that there are some variables, correlated with both productivity and internalisation modes, which drive this positive correlation. Therefore, the alleged ranking in productivity still needs further empirical support based on appropriate datasets allowing the researchers to overcome the aforementioned drawbacks.

This paper contributes to the scant literature on the issue by analysing the links between productivity and the decision of exporting and/or undertaking horizontal FDI for a large sample of Italian manufacturing firms, composed of both large and small-medium sized firms. The database we use contains, alongside with standard balance sheet data, data on several firm characteristics (e.g. age, innovative activities) as well as detailed information on firms' global engagement. By using the information on export activity and on the output produced in the foreign plant (i.e. its final destination and whether it is a finished or an intermediate good) we first identify those firms performing exporting and/or horizontal FDI; we then estimate production functions at the industry level to compute firms' measures of Total Factor Productivity (TFP, henceforth). Following the current practice on the issue, we compare the distribution of productivity by each category (domestic, exporting, exporting and FDI firms) through non parametric tests of stochastic dominance. We finally depart from most of the previous empirical literature by using estimated TFP as regressor in a multinomial logit model to assess whether productivity positively affects firms' choice to internationalise and whether the impact is larger for FDI than for export. In doing so, we control for other determinants of firms' internationalisation decision such as innovative activity, investments in ICT, age, size, group membership, labour composition, geographical location, as well as industry-specific effects.

Our results do confirm the ranking of productivity predicted by theoretical models. Non parametric tests show that firms performing FDI display higher TFP levels than exporters, which in turn are more productive than firms serving only the domestic market. This result also emerges from the econometric analysis based on multinomial choice models. Regardless of the method used to estimate TFP, a multinomial equation including only productivity, location, and industry dummies clearly confirms theoretical predictions. The inclusion of

other determinants of multinationalisation choice partially captures the impact of TFP but its effect remains significant and larger for FDI firms than for exporters.

The paper is organised as follows. The next section reviews the main theoretical contributions on the issue of heterogeneity and internationalisation choices and the existing empirical evidence, whereby motivating our paper. Section 3 describes our dataset whereas section 4 presents the different estimation procedures used to construct TFP and the results of non parametric tests of stochastic dominance. Section 5 comments upon the results of the multinomial choice model and section 6 contains some final remarks. An appendix containing a detailed data description and the variable definition concludes the paper.

2 Firms' heterogeneity and internationalisation modes: theory and empirical evidence

Literature on international trade has recently departed from industries or representative firms, the relevant elements of the Hecksher-Ohlin model and of the so called "new trade theories", to focus on inter-firm heterogeneity. In particular, several studies, both theoretical and empirical, show that productivity is one of the key determinants of firms' internationalisation choice.

Models of industry dynamics (e.g. Hopenhayn, 1992), provide a useful theoretical framework that relates firms' decisions to entry or exit from a market with their productivity level. These models have been extended to explain the export choice: because of the higher costs required to serve a foreign market (e.g. marketing expenses, distribution and transportation costs) only the most productive firms can self select in the export activity. The study of Roberts and Tybout (1997) confirms the existence of sunk costs related to the export activity.

This prediction has been empirically tested on large datasets at the firm level. A host of studies, pioneered by Aw and Hwang (1995) and Bernard and Jensen (1995), consistently find that exporters are more productive than firms serving only the domestic market, a result confirmed by the empirical literature focusing on the direction of causality between export and firms' performance (see for instance Clerides *et al.* (1998), Bernard and Jensen

(1999), Delgado *et al.* (2002)).[1]

More recent studies extend the analysis by focusing on horizontal FDI as alternative to export in serving foreign markets. Theoretical models using representative firms (see Brainard, 1993) show that the choice between horizontal FDI and export is driven by the so-called *proximity concentration trade-off*. The FDI decision is more convenient when the advantage of proximity to the foreign market outweighs the advantage of concentrating all production in a single plant (due to economies of scale) and when plant costs at home and in the host country are lower than the transportation costs. Helpman, Melitz and Yeaple (2004) and Head and Ries (2003) extend the Brainard model by highlighting the importance of firms' heterogeneity in productivity in the choice between export and horizontal FDI. They show that productivity is the main determinant of internationalisation choice. Their models demonstrate that in order to export firms must possess a productivity level higher than the one necessary to survive in the domestic market and that a even higher threshold exists for the decision to engage in horizontal FDI. As a result the least productive firms serve only the domestic market, firms with intermediate level of productivity export, while the most productive perform horizontal FDIs.

The existence of a productivity ranking has been tested for a limited number of countries: Girma *et al.* (2004, 2005) for Ireland and the UK, Castellani and Zanfei (2006, 2007) for Italy, Arnold and Hussinger (2005) and Wagner (2006) for Germany, and Kimura and Kiyota (2006) for Japan.[2] These studies have followed one of two approaches. The most widely used has been to compute (total or partial) productivity measures and to perform non parametric tests of stochastic dominance to verify the ranking in productivity among these three internationalisation choices. A less used approach has been to regress productivity measures on dummies for internationalisation modes, controlling for some other covariates (see below for more on this approach). Overall, the empirical evidence tends to confirm the theoretical ranking especially for the comparison between FDI and exporters whereas less clear results are obtained in the exporters vs. non exporters comparison.[3]

The difficulty in finding detailed information on *both* export and multinational activities explains not only

[1] Surveys on the findings of the literature relating exports and productivity are Greenaway and Kneller (2007), Wagner (2007), and Castellani and Zanfei (2006), Chapter 3.

[2] For a survey of the findings of these papers see Greenaway and Kneller (2007).

[3] This latter finding is at odds with the robust evidence on the higher productivity of exporters with respect to firms serving only the domestic market, whereby casting some doubts on the reliability of these results. On this issue, see the references in footnote 1.

the low number of analyses on the issue but also some drawbacks these analyses suffer from. As pointed out by Greeneway and Kneller (2007), in fact, some samples are biased towards large firms and therefore against finding significant productivity differences. Furthermore, theoretical predictions refers only to horizontal FDI (i.e. FDI which substitute export activities) and not to other kinds of FDI, such as vertical ones, but the distinction between these kinds of FDI is hard to find.[4] Capital stock is often lacking in the data, leading to the use of labour productivity, a partial productivity measure less reliable than TFP. Finally, those papers which use unconditional comparison of productivity closely follow recent theoretical models, which assume an exogenous productivity advantage for firms serving foreign markets but fail to identify the sources of these advantages. In turn, this leaves the possibility that internationalised firms are not more productive *per se*, but that there are some variables, correlated with both productivity and internationalisation modes, which drive this positive correlation. Therefore, no room is left for firms to invest in fixed assets, adopt new technologies, or promote human capital growth in order to increase their productivity. The only exceptions are Kimura and Kiyota (2006) and Castellani and Zanfei (2006, 2007) who control whether the higher productivity of multinational firms (MNEs, henceforth) and exporters is robust to the inclusion of covariates. Kimura and Kiyota (2006) control for a set of covariates at the firm level such as capital intensity, age, size, foreign ownership, and R&D intensity. They find that TFP differentials remain even after the inclusion of these variables but they do not present their estimated coefficients nor discuss their expected impact. Castellani and Zanfei (2006, 2007), instead, explicitly explain the productivity advantage in the light of superior technological knowledge possessed by MNEs. They refer to the eclectic paradigm framework (Hymer, 1960; Dunning, 1970) - asserting that MNEs must possess some advantages to expand abroad - to identify these advantages in technological accumulation. The authors estimate TFP measures and control for technological variables when comparing productivity differentials among categories. In particular, Castellani and Zanfei (2007) regress estimated TFP on dummy variables for each firm category controlling for their innovative activities, such as the share of R&D personnel, dummies for the introduction of process and product innovation, for technological cooperation, and for patent applications. They

[4]For instance, Girma et al. (2004) use a definition of MNE which covers both vertical and horizontal FDI and firms with both manufacturing and selling activities abroad.

find that technological intensity variables explain most of the higher productivity of MNEs with respect to exporters and domestic firms.[5] [6]

We contribute to this scant literature along several directions. Firstly, we give a proper econometric structure to firms' internationalisation choices by estimating a multinomial logit model. In this light, our paper is similar in spirit to Basile *et al.* (2003) which estimate an ordered probit model to assess the impact of several covariates on a discrete Foreign Expansion Index (*FEI*, ranging from 0 to 3 according to whether: firms serve uniquely the domestic market, export only, export and perform foreign penetration activities, perform FDI as well). However, these authors do not include in their analysis any measure of TFP which instead is the focus of our paper. Secondly, our strategy allows us to simultaneously measure the impact of several factors, alongside with productivity, on the internationalisation mode firms choose. We exploit the richness of our dataset by including a large set of additional controls which might explain the choice between export and horizontal FDI. As some of them are correlated with both internationalisation and productivity, their omission might drive the positive correlation found in previous papers. A first group of variables represents firms' innovative activity. One possible measure of this activity is the formal R&D expenditures, i.e. the input of the innovation process. However, many firms do not perform any formal R&D activity but introduce innovations through the acquisition of patents and/or of new production processes or through other forms of technological knowledge. Therefore, we include variables related both with the input (R&D intensity, measured as R&D expenditures over turnover) and with the output (dummies for the introduction of product and process innovations) of the innovative activity. We also use as regressor a measure of ICT adoption. On the one hand, a large body of empirical literature has measured the correlation between ICT and productivity (for a recent survey, see Draca *et al.* 2006). On the other, it might be argued that improved monitoring ability from ICT promotes delegation of authorities (on this, see Del Mastro and Colombo, 2004) and ICT adoption reduces the transaction costs of moving activities outside the

[5] The authors control also for industry, size, location, and time dummies. The empirical analysis carried out in Castellani and Zanfei (2006) is very similar, although not identical, to the one presented in the text. For sake of brevity, we report only the results of Castellani and Zanfei (2007).

[6] The explanation of MNEs' higher productivity in the light of their superior technological capabilities has been put forth also by Criscuolo et al. (2005). However, they do not estimate TFP but refer to knowledge production functions. By estimating several models with different output measures, the authors are able to conclude that MNEs show a higher innovative activity than domestic counterparts.

firms and carrying them out at greater geographical distance. We also draw from previous literature which has identified size, age, group membership as main determinants, alongside with productivity and innovative activity, of firms' globalisation activities. A large size and the knowledge accumulated over time can overcome the fixed costs associated with operating abroad. Similarly, group membership might provide firms with the necessary marketing and financial resources to internationalise. Finally, as globalised firms perform some activities (such as exporting and/or coordination of foreign and domestic plants) which are mostly white collars activities, we also include as additional regressor a measure of labour composition, namely the percentage of blue collars over the total number of workers.

As an additional contribution, we extend the existing evidence for Italy provided by Castellani and Zanfei (2006, 2007). These authors use a relatively small and mostly composed of large firms dataset to focus on the distinction between domestic producers, exporters, and two types of multinational firms: those with non-manufacturing subsidiaries abroad (for selling purposes) and MNEs with operative plant in the foreign market. Their distinction of internationalisation modes, therefore, does not distinguish between horizontal and vertical FDI and they use only technological activity as covariate which explains productivity differentials. Our study, instead, uses a much larger dataset, composed also by small-medium sized firms, includes a richer set of covariates, and focuses on horizontal FDIs only.

3 Data overview

The data we use come from the 9^{th} survey "Indagine sulle imprese manifatturiere", a survey run by Capitalia (one of the largest Italian banks) covering the $2001 - 2004$ period. The 9^{th} survey contains information on several quantitative and qualitative variables for more than $4,000$ firms as well as their balance sheet data. The sample contains all Italian manufacturing firms with more than 500 employees whereas firms with less than 500 employees are selected on the basis of a stratified sample, so that small and medium sized firms are well represented.[7]

[7] For more details on the structure of the survey, sample selection, questions and variables definition see the Data Appendix.

Some of the questions refer to the internationalisation choices performed by surveyed firms. As for exports, firms are asked to report whether they exported or not in the last year covered by the survey (and the amount exported as a percentage of turnover). Unfortunately, a detailed question for FDI is not available in the questionnaire. Firms are not asked whether they possess production facilities abroad but only whether they performed FDI during the last three years, thereby preventing us to use this question to construct the stock of FDI firms. We circumvented this problem by relying on other survey questions. In fact, the survey contains detailed information also on delocalisation activities carried out abroad by Italian manufacturing firms, on the characteristics of output produced in the delocalised plant, on the final market for these products, and on the motivations for the delocalisation (see Appendix 7.2). Therefore, we identify horizontal FDI through the final destination of the output produced in the delocalised plant. We consider a firm as performing an horizontal FDI if the production of the delocalised plant is mainly sold as a final product and not reimported in Italy as an intermediate input.[8] Combining this information and that on export, we are able to distinguish three categories of firms: those producing and selling exclusively in the domestic market, those that produce in Italy and export, those that export and undertake horizontal FDI. As for the distribution of the three categories, approximately one fourth serve only the domestic market, the vast majority of firms export, whereas - as expected - only a minor proportion (4.6%) performs FDI (see Table A3).[9]

We used firms' balance sheet data to estimate production functions and to compute TFP. To this end, we performed standard cleaning procedures. We first deleted firms operating in non manufacturing industries and those with incorrect activity code. In order to get rid of anomalies (due for instance to merging or de-merging),

[8]See the data appendix for more details. We are aware that our classification is only a proxy for horizontal FDI. In particular, according to our definition the set of FDI firms might contain firms with contracts with foreign producers, i.e. foreign outsourcers. However, theoretical predictions and empirical analyses (see Tomiura, 2007) suggest that the productivity of foreign outsourcers should lie between that of domestic and of FDI firms; in turn, the inclusion of outsourcers in our sample should bias the results towards finding no significant differences, i.e. against the results we find. Notice also that we performed several checks on our sample of FDI firms. In fact, by exploiting the information on the type of output produced in the delocalised plant we checked that all firms we consider as horizontal FDI produce finished and not intermediate product in the delocalised plant. We also used the question on the motivation of the delocalisation as a further robustness check (see footnote 17). Notice, finally, that one advantage of our definition is that our sample includes foreign activities previously performed at home, so that we are able to focus on activities related to firm's core business, whereby excluding unrelated FDI.

[9]In the original sample only 12 firms were involved in horizontal FDI without exporting. As the majority of them do no pass the trimming procedure and we had some doubts on the reliability of the data for the remaining firms, we dropped these firms from the sample used for the multinomial equation estimations.

we then trimmed our sample by dropping those firms with abnormal values both in levels and differences (one year differences) for output and inputs. We also deleted firms with only one year of data and with missing data for the year 2002. Therefore, we retain $3,562$ firms ($10,289$ firm-year observations) with complete information on output and inputs for TFP estimation purposes (see Table A4 for descriptive statistics). The sample we use to estimate the multinomial choice equations is instead restricted to those $3,275$ firms with non missing data for the variables used as dependent variable and regressors (R&D expenditures, ICT adoption, age, group membership, size, process and product innovations, labour composition).

Table A.6 contains descriptive statistics for these covariates. Striking differences emerge across the different categories of firms. There is a clear increase in R&D intensity (measured as percentage of R&D expenditures over turnover), size (measured as number of employees), ICT adoption (a dummy if the firm has invested in software in the last three years), group membership, as well as introduction of product and process innovation when we consider in turn domestic firms, exporters, and FDI firms. As for age, domestic firms appear to be younger than globalised firms but no differences emerge between exporters and FDI. Finally, a decreasing pattern is recorded for labour composition (the percentage of unskilled workers over total number of employees) going from the domestic firms category to the FDI one. This evidence suggests that it might important to take into account these variables when comparing TFP differential across categories. To check the validity of this insight, we move on to our statistical analysis.

4 TFP estimation and unconditional comparison

The first step of our analysis consists in the measurement of productivity level. We assume a two factor Cobb-Douglas production function. Therefore, taking logarithms we have:

$$\ln Y_{it} = \gamma + \alpha \ln L_{it} + \beta \ln K_{it} + v_i + \eta_{it} \tag{1}$$

where Y_{it} is value added, L_{it} is labour, and K_{it} is capital. All these variables refer to firm i observed at time (year) t. v_i represents a time invariant firm specific fixed effect and η_{it} is a time-varying error component

(idiosyncratic shock).[10]

Several estimation methods are available, according to the structure of the model and in particular to the assumptions on the unobserved effects and the explanatory variables. We estimate industry specific production functions in (1) by using either fixed effects (FE) (or within estimator) or the Levinsohn and Petrin approach.[11] Unlike Ordinary Least Squares or Random Effect estimators, the FE estimator does not require orthogonality between regressors and the individual effect v_i, an unlikely assumption in the production function context. However, given the well known problem of simultaneity between the shock in productivity and input choices, we also implement the semi-parametric approach developed by Levinsohn and Petrin (2003), hereafter LP, a refinement of the seminal work of Olley and Pakes (1996). The LP approach employs inputs to control for unobservables and to solve the simultaneity problem: in fact, under some regularity conditions, intermediate inputs (in our case, a composite index of materials and services) can be used as a proxy for productivity. By using a semi-parametric estimation procedure it is possible to construct moment conditions and to obtain consistent estimates of the coefficients. In our analysis we rely on TFP computed with both methods as a robustness check of our results. In fact, given the different set of assumptions these estimators rely on, it is not possible to prefer one method over the other. For the FE approach we compute TFP by taking the exponential function of the estimated residuals; for the LP approach we compute TFP by first taking the exponential function of the estimated residuals, then averaging by firm, and finally dividing by the exponential function of the industry mean value of TFP.[12]

Table 1 shows mean and standard deviation of the TFP estimated by fixed effect and the LP procedure by internationalisation choice. The two methods yield, rather comfortingly, very similar measures of TFP. Most importantly, these measures clearly follow the ranking predicted by the theory: firms that serve only the domestic market have the lowest productivity level, and firms engaged both in export and FDI are the most productive.

[10] See the data appendix for inputs and output definition.

[11] Due to data constraint, we aggregated some of the 20 two digit manufacturing classes into 9 broader categories (see Section 7.3 and Table A.2 for details).

[12] Although we estimated production function at the industry level, TFP computed with the LP approach is not in deviation from the industry mean, as in the FE approach. We implement the LP method in Stata 9.2 by using the levpet routine available on the Stata website (additional information on this command can be found in Petrin et al., 2004). Notice that in the LP procedure the ν_i term in equation (1) is replaced by ω_{it}, a transmitted productivity component. See Table A.5 for capital and labour elasticities estimates across the different industries.

[Insert Table 1 about here]

This ranking in the mean value of TFP across categories is fostered by graphic comparison of the three cumulative distributions of TFP (see Graphs 1 and 2). Regardless of the estimation method, the productivity distribution for FDI firms lies always below (and to the right) of the distribution for exporters which in turn lies below the one for firms serving only the domestic market. We also perform statistical tests of first order stochastic dominance through Kolmogorov-Smirnov (K-S, henceforth) tests [13]. In particular, following Delgado *et al.* (2002) we perform tests of stochastic dominance of a given distribution $F(z)$ (for instance, the productivity distribution of FDI firms) with respect to another distribution $G(z)$ (for instance, the productivity distribution of domestic firms) by testing two hypotheses:

$$H_0 \quad : \quad F(z) - G(z) = 0 \qquad \forall\, z \in \Re \qquad vs. \qquad H_1 : F(z) - G(z) \neq 0 \qquad for\ some\ z \in \Re \tag{2}$$

$$H_0 \quad : \quad F(z) - G(z) \leq 0 \qquad \forall\, z \in \Re \qquad vs. \qquad H_1 : F(z) - G(z) > 0 \qquad for\ some\ z \in \Re \tag{3}$$

The first hypothesis is tested through the so-called two-sided K-S test whereas the second hypothesis is tested through the so-called one-sided K-S test. To have first order stochastic dominance of $F(z)$ with respect to $G(z)$ we need to reject the null in the first test and fail to reject the null in the second test. In words, we need to verify that the two distributions are different and that this difference is not due to the $F(z)$ distribution lying above $G(z)$.

For each couple of categories (exporters vs. domestic, FDI vs. domestic, FDI vs. exporters) we performed both two-sided and one-sided K-S tests. Inspection of Table 2 reveals that we strongly reject the null hypothesis of equality of the cumulative distribution in all the two-sided tests between the three possible couples of firms' categories. As we never reject the null in the one-sided test, we can conclude that the theoretical ranking is confirmed with our data.

[Insert Graphs 1 and 2 about here]

[13] More formally, given two cumulative distribution functions F and G for two comparison groups, we say that F first-order stochastically dominates G if $F(z) - G(z) \leq 0$ uniformly in $z \in \Re$ with strict inequality for some z.

[Insert Table 2 about here]

5 Multinomial equations: the effect of productivity and other covariates on firms' choices

Our previous analysis highlights that the three categories of firms do differ with respect to their TFP distribution. In this section we exploit the richness of our dataset and we foster this evidence based on *unconditional* TFP comparison by assessing the impact of productivity on internatoinalisation modes while controlling for the role of other covariates identified by previous literature as important drivers of firms' globalisation choices. To this end, we estimate a multinomial logit model where the polychotomous dependent variable is the internationalisation choice (the three categories of no internationalisation, export, export and FDI).

Table 3 shows the results of four multinomial logit models which differ either in the measure of TFP used as regressor (models (*i*) and (*ii*) vs. models (*iii*) and (*iv*)) or in the additional regressors (models (*i*) and (*iii*) vs. models (*ii*) and (*iv*)). In all models the base category is no export, so that coefficients of the regressors for a given choice (export or export and FDI) must be interpreted as differences with respect to the coefficients of the no export choice.[14]

[Insert Table 3 about here]

Models (*i*) and (*iii*) include only TFP as well as area and industry dummies as regressors. As expected, the coefficient of TFP is positive and highly significant for both categories and both models (*i*) and (*iii*). Furthermore, the elasticities of estimated probabilities with respect to TFP are higher for export and FDI than for export only.[15] We can therefore conclude that even controlling for area and industry dummies the

[14] Inclusion of estimated TFP as regressor obliged us to use bootstrapped standard errors to construct statistical tests (for a discussion of the well known estimated regressor problem see Wooldridge, 2002).

[15] To compare the effect of covariates on the dependent variables, we rely on the elasticity of the estimated probability for continuous regressors and on the estimated coefficients for dichotomous regressors.

positive impact of productivity on internationalisation is confirmed. Notice that coefficients of area dummies for the Centre and the South & Islands are negative in both models and significant, confirming the well known difficulties that firms located in these macro areas have to face in order to internationalise.[16]

We also control for additional determinants of internationalisation in models (*ii*) and (*iv*). We include size, age, R&D intensity, labour force composition (percentage of blue collar workers over total number of employees), dummies for ICT adoption, product and process innovations, and group membership. Following previous literature which finds a U-shaped relationship between size and export (e.g. Sterlacchini, 1999) we include both a linear and a quadratic term for size. Size, age, R&D intensity and the dummies for product and process innovation as well as for ICT adoption and group membership are all expected to exert a positive impact on internationalisation. Instead, a negative impact of labour force composition is expected for both globalisation modes.

As for size, the linear term is positive and highly significant, whereas the quadratic term is negative and it is significant only for exporters. The elasticity is positive for both categories and four times larger for MNEs than for exporters. This finding confirms our *a priori* that firm dimension positively affects globalisation choices, notably multinational activities.

As far as innovative activity is concerned, mixed results emerge. At the input level, R&D intensity seems to play a marginally positive role only for export but not for MNE firms. At the output levels, for both categories the dummy for product innovation shows a positive and highly significant coefficient whereas process innovation seems to exert a positive impact only for MNEs, although not significant. These results tend to confirm the previous evidence that innovative activity is an important determinant of both export and FDI decisions (see among others Barrios *et al.* (2003) and Aw *et al.* (2005) for export and Castellani and Zanfei (2006, 2007) for MNEs); however, our findings suggest that once we control for productivity the development of new products (and not of new process) is a key driver of the ability to compete at the international level.

The estimates of the labour composition variable suggest that MNEs are more skilled intensive than domestic firms whereas exporters differ only marginally. The higher percentage of skilled workers in MNEs may reflect

[16] On the issue of geographical differences in exporting behaviour of Italian firms, see Basile (2001).

the presence in the headquarter firm of coordination tasks with subsidiaries and the concentration of activities characterized by strong economies of scale such as marketing tasks.

The coefficient of the dummy for ICT investment is positive and very significant in both equations, thereby confirming the higher intensity in ICT adoption when firms delegate authority to a foreign plant. Age plays a positive role in globalisation activities as older firms seems to internationalise more than younger ones whereas group membership seems to affect only the choice to perform horizontal FDI but not to export. Finally, the coefficients of the area dummies have the same sign and similar significance levels than in the base model.

Most importantly for the purposes of this paper, the significance of TFP is affected only marginally by the inclusion of these additional regressors. The estimated coefficients and the elasticities of the estimated probabilities are lower in models (ii) and (iv) than those obtained in base models (i) and (iii), the decrease being sharper in the LP approach and notably for the FDI category. These findings show that additional regressors are correlated with TFP and therefore explain part of the impact on the dependent variables. However, the estimated coefficients are statistically significant for both categories in models (ii) and (iv) and the effect is larger, in terms of both coefficients and elasticities, for FDI firms than for exporters. Therefore, it appears that even taking the effect of other variables into account, firms' productivity exerts a strong and positive effect on globalisation choices, particularly for the FDI choice.[17]

6 Final remarks

Recent theoretical models have emphasized the importance of heterogeneity in productivity as the key determinant of firms' internationalisation choices. The ranking in productivity these models predict has been vindicated - so far - by scant empirical evidence. However, a more traditional literature has identified other firm-specific fac-

[17] We performed some robustness checks of our results. We estimated the production function in (1) also by OLS and random effects. The results are virtually unaltered. Results are also unaffected by different trimming procedures and by computation of capital through the perpetual inventory method. We also estimated more general three factors industry-specific production functions, with real output as dependent variable and intermediate good as additional regressor. Although results for the fixed effects are very similar to those presented in the text, our coefficients are imprecisely estimated with the Levinsohn and Petrin approach which might be due to the difficulty in identifying the intermediate good coefficient once it is also used as proxy for productivity. Finally, we used the survey question on motivation (question D3.2.4, see Section 7.3) to select in the export and FDI category only those firms explicitely stating that delocalisation was driven by proximity. Our results are confirmed, although they are less pronounced than those in the text due to the low number of observations. All these additional results are available upon request to the authors.

tors, in particular superior technological knowledge, which explain firms' choice to globalise and are potentially correlated with productivity.

Therefore, two empirical questions arise: the first one is whether productivity matters for globalisation choices; the second one is whether productivity remains an important factor once we take into account other attributes, i.e. whether the positive correlation between productivity and internationalisation choices is not spuriously driven by common firm-level determinants.

To address these issues, we perform our analysis not only by using simple comparison of TFP distributions across categories of firms, but also by estimating multinomial regression models in which the types of engagement in international markets are jointly explained by productivity and by those variables identified by previous literature as important drivers of globalisation activities.

Overall, our results provide a positive answer to the two aforementioned questions. Our unconditional comparison across categories - based on first order stochastic dominance tests - do confirm the theoretical prediction that productivity matters. FDI firms clearly show higher productivity levels than exporters which in turn are more productive than domestic firms. This result holds for both methods we used for estimating production function and hence to compute productivity, namely the FE and the LP approach. The same finding emerges also from our base multinomial model specification where internationalisation choices are regressed on TFP and geographical dummies. When we jointly consider productivity and other heterogeneity attributes in multinomial models, the coefficients of the TFP variable decrease in value but are still significant. This finding suggest that other observable factors *only partially* explain the superior productivity of globalised firms. TFP not only remains a significant variable affecting internationalisation modes but it appears to play - as suggested by recent theoretical models - a more important role for FDI than for export.

By including other covariates, alongside with TFP, in our regression, we are able to depict how exporters and MNEs differ with respect to domestic firms. Apart from being more productive, our results confirm that globalised firms are larger and older than domestic ones. They also display a different organizational structure, characterised by higher skill intensity, more intense innovative activity, and greater ICT usage. Furthermore, they are more likely than domestic firms to belong to business groups.

As a final comment, we are aware that our paper, like most literature on this issue, is only able to detect correlation among the variables and is not able to identify the causality links between productivity and internationalization modes. Unfortunately, we could overcome this limitation only with a dataset covering a longer time period. Nonetheless, by using other covariates in our regression analysis, we are able to eliminate omitted variables as one possible source of endogeneity in the measurement of the effect of productivity on globalisation modes.

References

[1] Arnold, J. and Hussinger, K. (2005): "Export versus FDI in German Manufacturing: Firm Performance and Participation in International Markets", ZEW Discussion Paper N° 05-73

[2] Aw, B. Y. and Hwang, A. R (1995): "Productivity and Export Market: A Firm Level Analysis", *Journal of Development Economics*, XLVII(2), 313-332

[3] Aw, B. Y., Roberts M. J., and Winston, T. (2005): "The Complementarity Role of Exports and R&D Investments as Sources of Productivity Growth", NBER Working Paper No. W11774

[4] Barrios, S., Görg, H. and Strobl, E. (2003): "Explaining Firms' Export Behaviour: R&D, Spillovers and the Destination Market", *Oxford Bullettin of Economics and Statistics*, 65(1), 475-496

[5] Basile, R., (2001): "Export behaviour of Italian manufacturing firms over the nineties: the role of innovation", *Research Policy*, 30(8), 1185-1201

[6] Basile, R., Giunta A., and Nugent, J. (2003): "The Foreign Expansion by Italian Firms in the Nineties: an Ordered Probit Analysis", *Review of Industrial Organization*, 23(1), 1-24

[7] Bernard, A.B. and Jensen, B. (1995): "Exporters, Jobs and Wages in US Manufacturing, 1976-1987", Brookings Papers on Economic Activity, Microeconomics

[8] Bernard, A.B. and Jensen, B. (1999): "Exceptional exporter performance: cause, effect, or both?", *Journal of International Economics*, 47(1), 1-25

[9] Brainard, S. L. (1993): "A Simple Theory of Multinationals Corporations and Trade-Off Between Proximity and Concetration", NBER Working Paper N° 4269

[10] Brainard, S. L. (1997): "An Empirical Assesment of the Proximity-Concentration Trade-Off between Multinational Sales and Trade", *American Economic Review*, 87(4), 520-44

[11] Castellani, D. (2002): "Export behavior and productivity growth: evidence from Italian manufacturing firms", *Weltwirtschaftliches Archiv - Review of World Economics*, 138(4), 605-628

[12] Castellani, D. and Zanfei, A. (2006): *Multinational Firms, Innovation and Productivity*, Edward Elgar

[13] Castellani, D. and Zanfei, A. (2007): "Internationalisation, Innovation and Productivity: how do firms differ in Italy?", *The World Economy*, 30(1), 156–176

[14] Clerides, S. K., Lach, S. and Tybout, J R. (1998): "Is Learning by Exporting Important? Micro-Dynamics Evidence from Colombia, Mexico and Morocco", *Quarterly Journal of Economics*, CXIII(3), 903-947

[15] Criscuolo, C., Haskel, J. E., and Slaughter, M. (2005): "Global engagement and the innovation activities of firms", NBER Working Paper No. 11479

[16] Delgado, M. A., Fariñas, J.C. and Ruano, S. (2002), "Firm Productivity and Export Markets: a Non-parametric Approach", *Journal of International Economics*, 57(2), 397-422

[17] Del Mastro, M. and Colombo, M. (2004), "Delegation of authority in business organizations: An empirical test", *Journal of Industrial Economics*, LII(1), 53-80

[18] Draca, M., Sadun, R., and Van Reenen, J. (2006): "Productivity and ICT: a Review of the Evidence", CEP Discussion Paper No. 749

[19] Dunning, J. H. (1970): *Studies in International Investment*, Allen & Unwin

[20] Girma, S., Görg, H. and Strobl, E. (2004): "Exports, international investment, and plant performance: evidence from a non-parametric test", *Economics Letters*, vol. 83(3), 317-324

[21] Girma, S., Kneller, R. and Pisu, M. (2005): "Exports versus FDI, An empirical test", *Review of World Economics*, 141(2), 193-218

[22] Greenaway, D. and Kneller, R. (2007): "Firm Heterogeneity, Exporting and Foreign Direct Investment", *The Economic Journal*, 117(February), F134-F137

[23] Head, K. and Ries, J. (2003): "Heterogeneity and the FDI versus export decision of Japanese Manufacturers", *Journal of the Japanese and International Economics*, 17(4), 448-467

[24] Head, K. and Ries, J. (2004): "Exporting and FDI as Alternatives Strategies", *Oxford Review of Economics Policy*, 20(3), 409-423

[25] Helpman, E., Melitz, M. J. and Yeaple, S. R. (2004): "Export versus FDI with Heterogeneous Firms", *American Economic Review*, 94(1), 300-316

[26] Hymer, S. (1960): *The international operations of national firms: a study of direct investment*, Ph.D. thesis published in 1976 by MIT Press, Cambridge, MA

[27] Hopenhayn, H. (1992): "Entry, Exit, and Firm Dynamics in Long Run Equilibrium", *Econometrica*, 60(5), 1127-1150

[28] Kimura, F. and Kiyota, K. (2006): "Exports, FDI, and Productivity: Dynamic Evidence from Japanese Firms", *Weltwirtschaftliches Archiv - Review of World Economics*, 142(4), 695-719

[29] Levinsohn, J. and Petrin, A. (2003): "Estimating Production Functions Using Inputs to Control for Unobservables", *Review of Economic Studies*, 70(2), 317-341

[30] Olley, G. S. and Pakes, A. (1996): "The Dynamics of Productivity in the Telecommunications Equipment Industry", *Econometrica*, 64(6), 1263-1297

[31] Petrin, A., Poi, B. P. and Levinsohn, J. (2004): "Production function estimation in Stata using inputs to control for unobservables", *Stata Journal*, 4(2), 113-123

[32] Roberts, M.J. and Tybout, J.R. (1997): "The decision to export in Colombia: An empirical model of entry with sunk costs", *American Economic Review*, 87(4), 545–564

[33] Sterlacchini, A. (1999): "Do innovative activities matter to small firms in non R&D industries? An application to export performances", *Research Policy*, 28(8), 819-832

[34] Tomiura, E. (2007): "Foreign outsourcing, exporting, and FDI: A productivity comparison at firm level", *Journal of International Economics,* 72(1), 113-127

[35] Wagner, J. (2006): "Exports, foreign direct investment, and productivity: evidence from German firm level data", *Applied Economics Letters*, 13(6), 347-349

[36] Wagner, J. (2007): "Exports and Productivity: A survey of the evidence from Firm-level data", *The World Economy*, 30(1), 60-82

[37] Wooldridge, J. M. (2002): *Econometric Analysis of cross section and panel data*, MIT Press

7 Data appendix

7.1 Sample Description

The source of our dataset is the 9^{th} wave (covering the 2001-2003 period) of the survey run every three years by Capitalia Observatory on Medium and Small firms (previously Medio Credito Centrale Observatory). The survey contains detailed quantitative and qualitative information on a large sample of Italian firms and reports their balance sheet data for the three years covered by the survey. The survey sample contains all Italian manufacturing firms with more than 500 employees whereas firms with less than 500 employees are selected on the basis of a stratified sample.

From the original sample we dropped firms whose main activity is in a non manufacturing industry (classes 10, 23, and 39 in the Ateco 91 classification, 2 digit level). We then adopted standard cleaning procedures by removing: *i*) firms with incomplete information on internationalisation choices; *ii*) firms with extreme values for the variables used in the production function estimation; *iii*) firms with only one observation over the three years; *iv*) firms with no data for the year 2002. In particular, we removed firms with extreme values (both in level and differences) for inputs and output by using the 0.5 and the 99.5 percentiles as lower and upper thresholds and we dropped those firms with no balance sheet data for the year 2002 as this prevented us to construct the intermediate good we use as instrument for the Levinsohn and Petrin procedure. This sample is composed of $3,562$ firms and it is the one we use to estimate production functions and TFP. To construct the sample for multinomial logit estimates, we dropped a few firms involved only in FDI (but not in export) because of unreliable data and those firms with missing data for the regressors in multinomial choice equations. The final sample is composed of $3,275$ firms.

The following table describes the original sample and the retained sample for production function and multinomial choice estimations.

Table A.1: Original sample size and retained observations

	Before cleaning	*After cleaning*	
		Production function sample	Multinomial sample
Number of firms	$4,289$	$3,562$	$3,275$
Number of observations	$12,867$	$10,289$	$9,469$

7.2 Survey questions

The 9^{th} wave of the Capitalia survey contains a section on delocalisation of production. The questions we use are listed below. Notice that previous waves of the survey do no contain detailed information on delocalization preventing us to identify whether firms change their state over time.

D3.1 At present the firm performs at least part of his production abroad?

D3.2.1 What kind of product is produced abroad?

- Finished goods
- Intermediate goods
- Both

D3.2.4 Which are the reasons why the firm produces abroad? (*Multiple answers allowed*)

- Low labour cost
- Availability of raw materials

- Need to reduce prices to keep market shares
- Proximity to markets
- Tax advantages
- Loose environmental and labour regulation
- Others

D3.2.5 Destination of production performed abroad (%):

- Sold in the production country
- Imported in Italy to be used as input in the production process
- Imported in Italy to be sold in the Italian market
- Imported in Italy to be reexported in other countries
- Sold directly to third countries

7.3 Variables definition

Output (S): values of shipments plus changes in stock of finished goods and capitalised costs.
Value added (Y): turnover minus costs for materials and services, deflated with the corresponding three-digit producer price index.
Fixed Capital (K): book value of capital.
Labour (L): labour costs from balance sheet deflated with a wage index.
Intermediate good (M): Tornquist index of real materials and real services, where materials are deflated with the corresponding price index and services with the GDP deflator.
Industry dummies: 20 industry dummies have been included in the multinomial equations (15 – food and beverages; 17 – textiles; 18 – clothing; 19 – leather; 20 – wood; 21 – paper products; 22 – printing and publishing; 24 – chemicals; 25 – rubber and plastics; 26 – non-metal minerals; 27 – metals; 28 – metal products; 29 – non-electric machinery; 30 – office equipment and computers; 31 – electric machinery; 32 – electronic material, measuring and communication tools, TV and Radio; 33 – medical apparels and instruments; 34 – vehicles; 35 – other transportation; 36 – furniture). Each dummy equals 1 if firm's main activity is in that industry and 0 otherwise. Due to data limitations, we used 9 coarser industries in order to estimate production functions by aggregating the following two digit sectors: 17 to 19, 20 to 22, 24 and 25, 26 to 28, 30 to 33, 34 and 35 (see Table A.2).
R&D intensity: ratio of expenses in R&D over real output averaged over the three years period
Size: number of employees averaged over the three years period.
Age: measured as 2002 minus the establishment year.
Software: dummy variable, 1 if the firm has invested in software and 0 otherwise.
Group: dummy variable, 1 if the firm belongs to a business group and 0 otherwise.
Labour composition: percentage of the average number of blue collars over average total number of employees.
Product innovation: dummy variable, 1 if the firm has introduced a product innovation in the three years period and 0 otherwise.
Process innovation: dummy variable, 1 if the firm has introduced a process innovation in the three years period and 0 otherwise.
Area Dummies: 4 geographical dummies have been included in all equations (1 – North-West; 2 – North-East; 3 – Centre; 4 – South).
Internationalization choice: we use in the multinomial equation a three-category dependent variable which takes the following values: 1 for domestic firms, i.e. those not involved in exporting nor in horizontal FDI; 2 for exporting only firms, and 3 for firms exporting and performing an horizontal FDI. We define the set of horizontal FDI firms according to the survey question referring to the destination of the foreign plant's output (question

D3.2.5). In particular, for a firm to perform an horizontal FDI two criteria must be met: 1) the output must be either sold in the host country, or exported in a third country or is re-imported in Italy both for the Italian market or for being re-exported again; 2) the percentage of the output of the foreign plant reimported in Italy to be reintroduced in the production cycle must not exceed 50% of the total foreign production. The rationale here is the following. As a firm can perform both vertical and horizontal FDIs, we use the first criteria to select those firms which perform horizontal FDI and the second criteria to eliminate those firms which mainly perform vertical FDI.

Table A.2: Industry composition, number of firms by industry and category

Ateco 91 2-digit classification	*n° firms prod. function sample*	*n° firms multinomial sample*	*Category*
15 – Food and Beverages	388	366	1
17 – Textiles	284	248	
18 – Clothing	115	109	2
19 – Leather	149	142	
20 – Wood	96	91	
21 – Paper products	99	95	3
22 – Printing and publishing	90	87	
24 – Chemicals	202	174	4
25 – Rubber and plastics	194	179	
26 – Non-metal minerals	220	211	
27 – Metals	130	115	5
28 – Metal products	478	455	
29 – Non-electric machinery	515	457	6
30 – Office equipment and computers	7	4	
31 – Electric machinery	135	121	
32 – Electronic material	70	64	7
33 – Medical apparels and instruments	61	53	
34 – Vehicles	59	55	8
35 – Other transportation	31	27	
36 – Furniture	239	222	9
Total	3,562	3,275	

Note: For production function estimation purposes we aggregated some two digit industries to form the 9 broader categories.shown in the last column

Table A.3: Internationalisation choices, by firms

Category	*n° obs.*	*Percentage*
Domestic firms	838	25.59
Exporters only	2,286	69.80
Exporters and FDI	151	4.61
Total	3,275	100

Table A.4: Descriptive statistics of output and inputs

Variable	*Mean*	*St. dev.*	*Min*	*Max*
Value Added	6,449.72	14,596.4	179.07	191,831.0
Labour cost	3,819.68	8,419.53	170.30	105,248.3
Capital	5,584.19	13,467.5	14.09	171,932.7

Note: All variables are in thousand euros, real terms 2000 prices. Statistics are computed on the 10,289 observations used in the TFP estimation. For the definition of output and input variables see Section 7.3.

Table A.5: Capital and Labour elasticities estimates

Category	*Fixed Effect*		*Levinsohn & Petrin*	
	Capital	*Labour*	*Capital*	*Labour*
1	0.015	0.755**	0.086**	0.762**
	(0.029)	(0.068)	(0.033)	(0.047)
2	0.060**	0.904**	0.079**	0.736**
	(0.021)	(0.084)	(0.021)	(0.002)
3	0.073**	0.683**	0.063	0.829**
	(0.024)	(0.107)	(0.043)	(0.004)
4	0.055*	0.672**	0.056**	0.753**
	(0.022)	(0.072)	(0.002)	(0.048)
5	0.053**	0.790**	0.125*	0.764**
	(0.019)	(0.070)	(0.058)	(0.020)
6	0.066**	0.881**	0.103*	0.808**
	(0.018)	(0.070)	(0.045)	(0.012)
7	0.032	0.982**	0.085	0.801**
	(0.027)	(0.068)	(0.054)	(0.010)
8	0.057	0.805**	0.128**	0.723**
	(0.049)	(0.080)	(0.024)	(0.055)
9	0.009	0.707**	0.032**	0.793**
	(0.028)	(0.072)	(0.003)	(0.024)

Note: robust standard errors in parenthesis; for categories definition see Table A.2
* significant at 5%; ** significant at 1%

Table A.6: Descriptive statistics of regressors in the multinomial logit equations

	R&D	*Size*	*Software*	*Age*	*Group*	*Product*	*Process*	*Unskilled*
Domestic (838)								
Mean	0.32	54.26	0.48	24.55	0.21	0.24	0.39	69.56
Sd	1.28	96.73	0.50	16.28	0.40	0.43	0.49	19.91
Min	0	7.33	0	0	0	0	0	0
Max	13.84	1604.33	1	143	1	1	1	100
Exporters (2,286)								
Mean	0.82	101.08	0.62	27.94	0.30	0.49	0.49	66.78
Sd	2.44	163.26	0.48	19.47	0.45	0.50	0.50	17.60
Min	0	10.33	0	0	0	0	0	0
Max	54.68	2793.66	1	190	1	1	1	100
Exporters and FDI (151)								
Mean	0.92	215.86	0.77	28.63	0.58	0.58	0.60	59.05
Sd	1.55	368.46	0.41	20.19	0.50	0.49	0.49	21.00
Min	0	10.33	0	2	0	0	0	0
Max	7.91	2862	1	129	1	1	1	94.31
Total (3,275)								
Mean	0.69	94.40	0.60	27.10	0.29	0.43	0.47	67.13
Sd	2.17	168.34	0.49	18.79	0.45	0.49	0.50	18.50
Min	0	7.33	0	0	0	0	0	0
Max	54.68	2862	1	190	1	1	1	100

Note: Regressors are defined in Section 7.3. In round brackets the number of firms belonging to that category

Table 1: Descriptive statistics, TFP indexes

	Fixed Effect	*Levinsohn & Petrin*
Domestic	0.94(0.38)	0.95(0.35)
Exporters	1.07(0.41)	1.06(0.37)
Exporters and FDI	1.21(0.42)	1.21(0.36)

Notes: Mean of TFP (standard deviation in brackets) for the 3,275 firm-level means used as regressor in the multinomial choice equations

Table 2: Kolmogorov-Smirnov tests for first order stochastic dominance

	Fixed Effect		*Levinsohn & Petrin*	
	Two sided	One sided	Two sided	One sided
Domestic vs Exporters	0.204(0.000)	−0.003(0.993)	0.194(0.000)	−0.002(0.997)
Domestic vs Exporters and FDI	0.374(0.000)	−0.007(0.987)	0.376(0.000)	−0.011(0.971)
Exporters vs Exporters and FDI	0.209(0.000)	−0.008(0.981)	0.241(0.000)	−0.011(0.969)

Notes: Two sided is a test of the null that the two cumulative distribution functions are equal against the alternative that they differ. One sided is a test of the same null hypothesis against the alternative that the distribution of the second group lies above the cumulative distribution function of the first group. All tests are run on the sample of 3,275 firm-level means used as regressor in the multinomial choice equations.

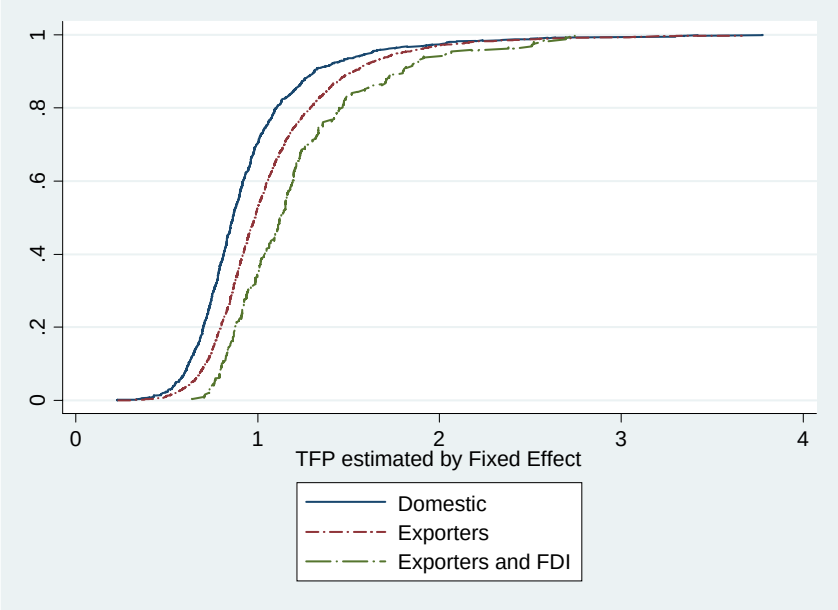
Table 3: Estimates of the Multinomial Logit model

	(i)		(ii)		(iii)		(iv)	
Model	FE base		FE full		LP base		LP full	
Dependent variable Category	(2)	(3)	(2)	(3)	(2)	(3)	(2)	(3)
TFP	1.191	1.793	0.764	1.012	1.229	1.903	0.706	0.801
	(5.15)**	(5.63)**	(3.88)**	(3.58)**	(6.13)**	(6.60)**	(4.05)**	(2.70)**
R&D	..	..	0.078	0.015	..	..	0.080	0.015
			(1.69)	(0.25)			(1.67)	(0.23)
Size	..	..	0.004	0.006	..	..	0.005	0.006
			(3.13)**	(3.16)**			(3.88)**	(3.79)**
Size squared	..	..	−0.002	−0.002	..	..	−0.002	−0.002
			(1.99)*	(1.42)			(2.28)*	(1.88)
Software	..	..	0.211	0.720	..	..	0.217	0.721
			(2.30)*	(3.31)**			(2.29)*	(2.87)**
Age	..	..	0.009	0.014	..	..	0.008	0.013
			(3.24)**	(2.87)**			(3.08)**	(2.86)**
Group	..	..	0.021	1.041	..	..	0.021	1.039
			(0.16)	(4.74)**			(0.19)	(4.53)**
Product inno	..	..	0.776	0.821	..	..	0.771	0.821
			(7.67)**	(3.14)**			(6.22)**	(3.56)**
Process inno	..	..	0.018	0.292	..	..	0.019	0.305
			(0.19)	(1.34)			(0.20)	(1.38)
Unskilled	..	..	−0.004	−0.020	..	..	−0.004	−0.021
			(1.19)	(3.42)**			(1.18)	(3.85)**
North-East	−0.024	0.229	0.011	0.308	−0.023	0.227	0.013	0.301
	(0.19)	(0.90)	(0.09)	(1.14)	(0.18)	(0.91)	(0.11)	(1.00)
Centre	−0.457	−0.308	−0.369	−0.059	−0.445	−0.276	−0.363	−0.044
	(3.68)**	(0.99)	(2.63)**	(0.17)	(3.57)**	(1.01)	(2.75)**	(0.15)
South & Islands	−0.670	−1.454	−0.446	−0.968	−0.640	−1.427	−0.428	−0.948
	(4.68)**	(2.98)**	(2.83)**	(2.02)*	(4.21)**	(3.05)**	(2.65)**	(1.90)*
Constant	−0.128	−5.562	−0.410	−5.681	−0.185	−5.691	−0.363	−5.393
	(0.49)	(0.74)	(1.31)	(0.71)	(0.78)	(0.81)	(0.98)	(0.66)
Log-Likelihood	−2,166.5		−2,025.9		−2,167.6		−2,030.1	
Pseudo R^2	0.108		0.166		0.108		0.164	
Elasticity TFP	[0.25]	[0.88]	[0.17]	[0.43]	[0.26]	[0.97]	[0.17]	[0.27]
Elasticity R&D	..	..	[0.01]	[−0.04]	..	..	[0.01]	[−0.04]
Elasticity Size	..	..	[0.04]	[0.16]	..	..	[0.04]	[0.17]
Elasticity Age	..	..	[0.05]	[0.18]	..	..	[0.05]	[0.18]
Elasticity Skilled	..	..	[−0.02]	[−1.14]	..	..	[−0.02]	[−1.20]

Note: The number of observations is 3,275 for all equations. The base category is domestic firms, (2) indicates the equation for exporters and (3) the equation for exporters and FDI. The coefficient of size squared is multiplied by 1,000. Absolute value of z statistics in round brackets (statistics based on bootstrapped standard errors, 100 replications). Two-digit industry dummies are included in all equations but not shown. Elasticity $\left(\frac{dP/P}{dx/x}\right)$ is the mean percentage change in probability given a 1% increase in the regressor. For size, it measures the overall effect of the linear and the quadratic terms.

* significant at 5%; ** significant at 1%

Graph 1: Cumulative distribution of TFP estimated with Fixed Effects, by internationalisation mode



Graph 2: Cumulative distribution of TFP estimated with the Levinsohn & Petrin approach, by internationalisation mode