Firms' Productivity and Internationalisation Choices: Evidence for a Large Sample of Italian Firms*

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Abstract

This paper addresses the issue of the links between firms' productivity and internationalisation choices. By using detailed qualitative and quantitative information on a large sample of Italian firms (contained in the 9^{th} Capitalia survey) we first identify two internationalisation modes, i.e. exporting and delocalisation/horizontal FDI decisions. Following the literature on firm heterogeneity we estimate different measures of Total Factor Productivity and we provide empirical evidence on the positive role exerted by productivity on both export and FDI choices. By estimating a multinomial logit model, we also examine the effect on internationalisation choices of variables other than TFP such as size, R&D propensity, age, ICT expenses and group membership.

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1 Introduction

Recent literature in international trade has highlighted - through theoretical models and empirical analyses - the importance of firms' heterogeneity in affecting internationalization choices. In particular, it has been shown that the way firms enter international markets (i.e. through export or FDI) is not uniquely determined by industry characteristics such as transport costs and trade barriers but is driven also by firms' heterogeneity in productivity. The basic idea is that only firms with an above average level of productivity self select to afford the fixed costs entailed by operating in foreign markets (such as those entailed by market research and set up of new distribution channels) whereas the least productive firms choose to serve uniquely the domestic market. This strand of literature compared at first only the productivity of exporters and that of non-exporters and unanimously found a superior performance of the former. More recent literature has instead extended the productivity comparison by including a third group of firms, those with facilities in foreign countries: as the fixed costs associated with performing activities in a foreign country are higher than the costs associated with exporting, theory predicts that FDI firms should outperform exporters, which in turn should outperform firms serving only the domestic market.

Although intuitive and supported by some empirical evidence, this ranking of productivity according to internalisation modes raises some concerns. On the theoretical side, the models assume an exogeneous 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. Further concerns refer to causality: the positive correlation between productivity and internationalization cannot be given a causal interpretation, due to possible feedbacks from internationalization to productivity via learning by exporting or technology adoption. As for empirical evidence, only a few analyses have been performed so far. The lack of evidence is mostly due to the difficulty in finding suitable database containing detailed information on both export and multinational activities. Furthermore, there are some awkward difficulties in translating theoretical predictions into testable hypotheses. Theoretical models hypothesise monoproduct firms, only one

foreign markets, and only horizontal FDI (i.e. FDI which substitute export activities) whereas firms in the real world produce several products, face the choice of serving a host of different countries, and perform FDI for different purposes. The category of MNEs is therefore quite heterogeneous, as firms within this category might possess abroad either sales agencies or manufacturing facilities, might perform horizontal as well as vertical FDI, and might undertake abroad activities different from their core business at home. Theoretical predictions refer only to horizontal FDI, but it is difficult in empirical analyses to disentangle those different kinds of firms. To sum up, this alleged ranking in productivity still needs further support from empirical analyses using dataset which allow the researchers to deeply investigate the links between productivity and internationalization and to properly identify the type of FDI.

This paper contributes to the scant literature on the issue by analysing the role of productivity in the decision of exporting and undertaking horizontal FDI for a large sample of Italian manufacturing firms. By using detailed qualitative and quantitative information (contained in the 9^{th} Capitalia survey) we first identify firms performing two internationalisation modes: exporting and/or horizontal FDI and estimate production function at the firms' level to compute measures of Total Factor Productivity (TFP). Following the current practice on the issue, we then compare the distribution of productivity by firm category (no export, export, export and FDI) through non parametric tests. We finally depart from previous empirical literature by using estimated TFP as regressor in a multinomial logit 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 are able to control for other determinants of firms' internationalisation decision such as R&D expenses, investments in ICT, age, size, group membership, geographical location, as well as industry-specific characteristics.

Our results do confirm the ranking of productivity predicted by theoretical models. This result is robust with respect to the different estimation method used to measure productivity and to the inclusion of other determinants of multinationalization choice. In particular, R&D expenditures, ICT adoption, size, and age do affect the choice between serving only the domestic market and internationalise, whereas only ICT adoption appears to significantly affect the choice between exporting and performing FDI. Unfortunately, as most of the previous literature, we cannot attribute a pure causal interpretation to these results. There might be, for

instance, confounding factors that simultaneously affect productivity (or R&D) and the internationalization choices. The structure of our dataset, notably the short time length covered, does not allow us to identify firms' transitions among the three different states (domestic, export, and horizontal FDI) and thus prevents us from capturing clear causal relations between productivity and the decision to sell abroad. We leave this weakness of the present paper as further research, once new data will become available.

The paper is organised as follows. The next section reviews the main theoretical contributions on the issue of heterogeneity and internationalisation choices and the related empirical evidence. 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 equality of the TFP distributions. 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 new trade theories, to focus on interfirm heterogeneity. In particular, several studies, both theoretical and empirical, show that productivity is one of the main determinants of firms' internationalisation choice.

Models of industry dynamics (see for instance 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, i.e. 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.

The availability of large datasets at the firm level has allowed the researchers to provide empirical evidence on

the issue. Several studies (e.g. Aw and Wang, 1995 and Bernard and Jensen, 1995) unanimously find that firms selling in foreign countries 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 the horizontal FDI and export decision 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 outweights 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 or horizontal FDI. They show, in the framework of intra-industry heterogeneity models, 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 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 best performers do horizontal FDI. Head and Ries (2003), however, show that when horizontal FDI is oriented towards low cost countries the ranking in productivity threshold among internationalisation choices can be reversed.

The existence of a productivity ranking has been tested for different countries by a few empirical studies: Girma *et al.* (2004, 2005) for Ireland and the UK, Castellani and Zanfei (2006) for Italy, and Arnold and Hussinger (2005) for Germany. The main idea of these studies is to compare different measures of firm performance and perform tests of stochastic dominance to verify the ranking in productivity among the three internationalisation choices. Although these works aim at testing theoretical models, data constraints force them to use proxy or

[1] Surveys on export and productivity are Greenaway and Kneller (2005), Wagner (2006), and Castellani and Zanfei (2006), Chapter 3.

imprecise definition of horizontal MNEs. 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. As for Italy, Castellani and Zanfei (2006a,b) use a dataset different from ours. They 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. Our study, instead, uses a much wider dataset and is based on the occurred production and destinations of the output of delocalized plants (see next section), so that we are able to disentangle horizontal from vertical FDI.

These analyses provide empirical support to theoretical models as they unanimously confirm the productivity ranking across the three types of firms. However, they suffer from the same weakness that characterizes theoretical models, i.e. the productivity advantage is exogeneous to firms and is therefore left unexplained. 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 Criscuolo *et al.* (2005) and Castellani and Zanfei (2006a,b), who are, to the best of our knowledge, the only analyses which try to explain the advantage in the light of superior technological knowledge possessed by MNEs. In particular, Criscuolo *et al.* (2005) do not estimate TFP but refer to knowledge production functions. By estimating several models with different output measures are able to conclude that MNEs show a higher innovative activity than domestic counterparts. Similarly, Castellani and Zanfei (2006a,b) use the eclectic paradigm framework (Hymer, 1960; Dunning, 1970) asserting that MNEs must possess some advantages to go abroad and identify these advantages in technological accumulation. However, the authors esplicitely estimate TFP measures and control for technological variables when comparing productivity differentials among categories. Castellani and Zanfei (2006b) 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 find that technogical intensity variables explain most of the higher productivity of MNEs with respect to exporters and domestic firms.[2]

[2] The authors control also for industry, size, location, and time dummies. Notice also that the empirical analysis carried out in

We extend this approach in two respects. First, we use additional controls which might explain the choice between export and horizontal FDI. Notice that some of them, being correlated with both internationalisation and productivity, might also drive, if omitted, the positive correlation between them. In particular, we use - alongside with firms' innovative activity - 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, following previous literature on ICT and delegation of authority (see Del Mastro and Colombo, 2004) that improved monitoring ability from ICT incentivates delegation of authorities and, in turn, facilitate the ownership of production facilities abroad. Furthermore, we draw from previous literature on export (for a recent survey see Wagner, 2006 and for evidence on Italy see Basile *et al.*, 2003 and Sterlacchini, 1999) which has identified size, age, group membership as main determinants, alongside with productivity and innovative activity, of exporting activities. We suppose that all these variables migth affect also horizontal FDI. For instance, R&D expenses are supposed to complement export by facilitating knowledge absorption from foreign markets, so that they might be supposed to complement horizontal FDI as well. Second, we give an econometric structure to these internationalisation choices by using a multinomial logit model which allows us to measure simultaneously the impact of all these factors, in addition to productivity, on firms' choice for one internationalization mode instead of another. More importantly for the purposes of this paper, this strategy allows us control whether the positive correlation - found in previous analyses - between TFP and internationalisation are robust to the introduction of these variables.

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.[3]

Castellani and Zanfei (2006a) is similar, although not identical, to the one presented in the text. For sake of brevity, we discuss only the results of Castellani and Zanfei (2006b).

[3]For more details on the 9^{th} survey, sample description, question and variable 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 three-years period (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 an FDI during the last three years, whereby preventing us to use this question to construct the stock of FDI firms. We circumvented this problem by relying on other 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 (i.e. production at a foreign plant as a substitute of export) 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 not mainly reimported in Italy as an intermediate input.[4] Combining this information and the question 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 (see Table A3 for the distribution of these categories).[5]

We used firms' balance sheet data to estimate production functions and 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, 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, for TFP estimation purposes we retain 3,562 firms (10,289 firm-year observations) for

[4] See the data appendix for more details. We are aware that our classification is a proxy for horizontal FDI, i.e. production abroad that substitutes for export. In particular, according to our definition the set of FDI firms might contain firms with *contracts* with foreign producers. However, the inclusion of these firms, if true, should bias the results towards finding no significant differences among groups of firms, i.e. against the results we find. Notice also that we performed several checks our sample of FDI firms: 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 10).

[5] 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.

which we have complete information on output and inputs (see Table A4 for descriptive statistics). The sample used in estimation of the multinomial choice equations is restricted to those 3,275 firms with non missing data for the variables used as dependent variable and regressors (R&D expenditures, ICT, age, group membership, size).

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:

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

where Y_{it} is added value, 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).[6]

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. In particular, we estimate industry specific production functions in (1) by using either fixed effects (FE) (or within estimator) or the Levinsohn and Petrin approach.[7] Unlike Ordinary Least Squares or Random Effect estimators, the FE estimator does not require orthogonality between regressors and the individual effect v_i, a very 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, intermediated inputs (in our case, a composite index of materials and services) can be used as a proxy for

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

[7] Due to data constraint, we aggregated some of the 20 two digit manufacturing classes into 13 slitgtly broader categories (see Section 7.3 and Table A.2 for details).

productivity. By using a semi-parametric estimation procedure is possible to construct moment conditions and obtain consistent estimates of the coefficients.[8] We compute TFP by first taking the exponential function of the residuals estimated with the two approaches and then taking the average by firm.

Table 1 shows mean and standard deviation of the TFP estimated by fixed effect and the LP procedure by internationalisation choice. Both methods yield measures of TFP, although different in absolute value because of the differences in estimation procedure, which follow the ranking indicated 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.

[Insert Table 1 about here]

This ranking is confirmed by graphic inspection of the cumulative distribution of TFP for the three categories of firms (see Graphs 1 and 2). Regardless of the estimation method, the productivity distribution for FDI firms stochastically dominates (i.e. is always to the right of) the distribution for export firms which in turn dominates the one for firms serving only the domestic market. We performed Kolmogov-Smirnov tests and we strongly reject the null hypothesis of equality of the cumulative distribution between the three possible couples of firms' categories (see Table 2). Therefore, we can conclude that theoretical predictions are clearly confirmed with our data.

[Insert Graphs 1 and 2 about here]

[Insert Table 2 about here]

[8] We implemented this 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.

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. Most of the previous empirical literature stops here. However, we want to exploit the richness of our dataset and foster this evidence based on *unconditional* TFP comparison by assessing the impact of productivity on internalisation mode by controlling for the role of other covariates. To this end, we estimate a multinomial logit model in which 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 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 must be interpreted as the effect of the regressor on the given choice (export or export and FDI) with respect to the no export choice.[9]

[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 coefficient is higher for export and FDI than for export only, this difference is very significant, and also elasticities of estimated probabilities with respect to TFP are larger for the export and FDI category. We can therefore conclude that even controlling for area and industry dummies the 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.

[9] 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).

We control for additional determinants of internationalisation in models (*ii*) and (*iv*). We include size (as measured by the number of employees, Empl), R&D propensity (percentage of R&D expenditures over turnover), a dummy for positive expenses in software, age, and a dummy for group membership (see Table A5 for descriptive statistics for these variables). Notice that following previous literature which finds a U-shaped relatiohship between size and export (e.g. Sterlacchini, 1999) we include both a linear and a quadratic term for size. Size, R&D propensity and positive expenses in software are all expected to exert a positive impact on internationalisation.

As for size, the linear term is positive and highly significant, whereas the quadratic term is (marginally) not significant. The elasticity is positive for both categories and three times larger for MNEs than for exporters.This finding confirms our a priori that firm dimension positively affects multinationalisation choice, notably multinational activities. R&D propensity is found to exert a positive impact on export but not on export and FDI (although both coefficients are positive, elasticity is positive only for the export category). The finding that R&D activities play an important role for export is consistent with the view that to compete in foreign markets firms have to invest in R&D and confirms previous findings (see, for instance, Barrios et. al , 2003). On the contrary, the result that R&D propensity plays no role in export and FDI is quite new (for different findings see Castellani and Zanfei (2006a,b) and Aw *et al.* 2005) and needs further investigation. The coefficient of the dummy for ICT investment is positive and very significant in both equations, and the elasticity is much larger for export and FDI confirming the higher intensity in ICT adoption when firms delegate authority to a foreign plant. Old firms seems to internationalise more than younger firms whereas group membership seems to affect only the choice to perform horizontal FDI but not export. Finally, the coefficients of the area dummies confirm the sign and the significance levels they showed in the base model.

Most importantly for the purposes of this paper, the significance of TFP is affected only marginally and only in model (*iv*) by the inclusion of these additional regressors. It is therefore confirmed that even taking other variables into account, firms' productivity exerts a strong and positive effect on multinationalisation choices.[10]

[10] 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

6 Final remarks

Our analysis was intended to assess the prediction of recent theoretical works, vindicated by scant empirical evidence, of a ranking in productivity among firms with different internationalization modes. Our research strategy is based not only on simple comparison of TFP distributions across categories of firms, but also on multinomial regression models in which the types of engagement in international markets are jointly explained by those variables identified by previous literature as important. As some of these variables are correlated with productivity (R&D activities, ICT adoption), this strategy allows us not only to assess the importance of these additional covariates but also to identify the net impact of TFP on internationalisation. In particular, we find that size, R&D propensity, a dummy for ICT adoption, age, and group membership all exert a significant impact on internationalisation choices. A quite new finding is that R&D plays a more important role for export than for export and FDI. Most importantly, we find that the positive impact of TFP survives the inclusion of additional covariates.

These results have some policy implications.In particular, they highlight the reasons why Italian firms, characterised by small size and low investments rates in R&D and ICT, tend to concentrate their activities in the domestic market and suggest possible mechanisms for inducing firms to expand in foreign markets.

As a final comment, we are aware that our paper suffers from some limitations, thereby suggesting us a research agenda. The first limitation is the structure of the error term: the one implied by a multinomial logit model might be too restrictive, so that a nested logit model might be a more suitable alternative. The second limitation - although shared by most literature on this issue - is more serious. Due to lack of time series dimension in our data, we are not able to identify the causality links between productivity and internationalization modes. Unfortunately, we could overcome this weakness only with a dataset covering a longer time period.

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 and to the noise in the answer. All these additional results are available upon request to the authors.

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7 Data appendix

7.1 Sample Description

The dataset used comes from 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.

We dropped firms with main activity in non manufacturing industries (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 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 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 question 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 in 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?:

- 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

Real output (S): values of shipments plus changes in stock of finished goods and capitalised costs, deflated with the corresponding three-digit producer price index.
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 the wage index.
Intermediate good (M): Tornquist index of materials and services.
Industry dummies: 21 industry dummies have been included in 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 the firm main activity is in that industry and zero otherwise. Due to data limitations, we used 13 sligthly coarser industries in order to estimate production functions by aggregating the following two digit sectors: 17 and 18, 21 and 22, 30 to 33, 34 and 35 (see Table A.2)
R&D: ratio of the three-years averaged deflated expenses in R&D over real output.
Size: number of employees from the survey averaged over the three years.
Software: dummy variable equals to one if the firm have invested in software.
Group: dummy variable equals one if the firm belongs to a group.
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 value 1 for domestic firms, i.e. those not involved in exporting nor in horizontal FDI, value 2 for exporting only firms, and value 3 for firms exporting and performing an horizontal FDI. We define the set of horizontal FDI firms according to the survey question about the destination of the output of the foreign plant. In particular, for a firm to be an horizontal FDI firm 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.

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

Ateco 91 2 digit classification	*n° firms*	*Category*
15 – Food and Beverages	366	1
17 – Textiles	248	2
18 – Clothing	109	
19 – Leather	142	3
20 – Wood	91	4
21 – Paper products	95	5
22 – Printing and publishing	87	
24 – Chemicals	174	6
25 – Rubber and plastics	179	7
26 – Non-metal minerals	211	8
27 – Metals	115	9
28 – Metal products	455	
29 – Non-electric machinery	457	10
30 – Office equipment and computers	4	11
31 – Electric machinery	121	
32 – Electronic material	64	
33 – Medical apparels and instruments	53	
34 – Vehicles	55	12
35 – Other transportation	27	
36 – Forniture	222	13
Total	3,275	

Note: For production function estimation purposes we aggregated some two digit industries to form 13 broader categories.

Table A.3: Internationalisation choices, by firms

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

Table A.4: Descriptive statistics of output and inputs

Variable	*n° obs.*	*Mean*	*St. dev.*	*Min*	*Max*
Value Added	10,289	6,449.72	14,596.44	179.07	191,831.0
Labour cost	10,289	3,819.68	8,419.53	170.30	105,248.3
Capital	10,289	5,584.19	13,467.5	14.09	171,932.7

Note: All variables are in thousand euros, real terms 2000 prices.
For the definition of output and input variables see Section 7.3.

Table A.5: Descriptive statistics of regressors in the multinomial logit equations

	R&D	*Size*	*Soft*	*Age*	*Group*
Domestic (838)					
Mean	0.32	54.26	0.48	24.55	0.21
Sd	1.28	96.73	0.50	16.28	1.40
Min	0	7.33	0	0	0
Max	13.84	1604.33	1	143	1
Exporters (2,286)					
Mean	0.82	101.08	0.62	27.94	0.30
Sd	2.44	163.26	0.48	19.47	0.45
Min	0	10.33	0	0	0
Max	54.68	2793.66	1	190	1
Exporters and FDI (151)					
Mean	0.92	215.86	0.77	28.63	0.58
Sd	1.55	368.46	0.41	20.19	0.50
Min	0	10.33	0	2	0
Max	7.91	2862	1	129	1
Total (3,275)					
Mean	0.69	94.40	0.60	27.10	0.29
Sd	2.17	168.34	0.49	18.79	0.45
Min	0	7.33	0	0	0
Max	54.68	2862	1	190	1

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

Table 1: Descriptive statistics, TFP indexes (multinomial logit sample, $n = 3,275$)

	Fixed Effect	Levinshon and Petrin
Domestic	0.94(0.38)	2.27(0.91)
Exporters	1.07(0.41)	2.57(0.96)
Exporters and FDI	1.21(0.42)	3.00(0.92)

Notes: Mean of TFP (standard deviation in brackets). Absolute values differ because the Levinsohn and Petrin method does not include a constant in the estimation procedure.

Table 2: Two-sample Kolmogorov-Smirnov test for equality of distribution functions

	Fixed Effect		*Levinshon and Petrin*	
	Combined K-S	P-value	Combined K-S	P-value
Domestic vs Exporters	0.2048	0.000	0.2020	0.000
Domestic vs Exporters and FDI	0.3754	0.000	0.4502	0.000
Exporters vs Exporters and FDI	0.2108	0.000	0.2582	0.000

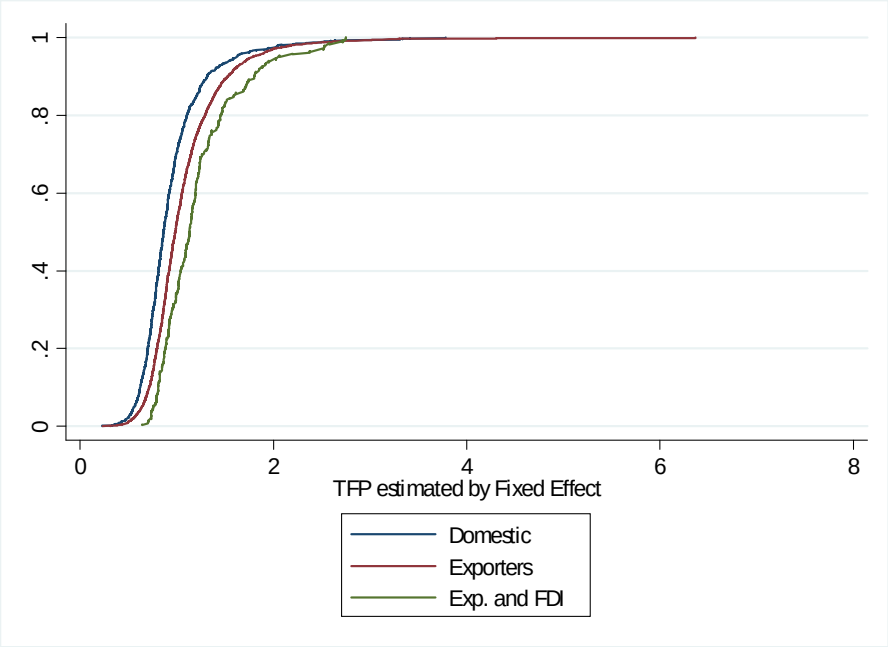
Notes: The combined Kolmogorov-Smirnov tests whether the cumulative distribution function of the first category lies above (below) if the statistics is positive (negative) the cumulative distribution function of the second category. All tests are run on the sample of 3,275 observations used in the multinomial choice equations.

Table 3: Estimates from Multinomial Logit.

	(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	1.192	1.793	0.837	1.277	0.466	0.708	0.295	0.436
	(5.11)**	(5.65)**	(4.21)**	(4.39)**	(6.06)**	(6.34)**	(3.69)**	(3.65)**
R&D	..	..	0.150	0.115	..	..	0.147	0.111
			(2.75)**	(1.72)			(2.74)**	(1.70)
Size	..	..	0.005	0.006	..	..	0.005	0.006
			(3.43)**	(3.30)**			(4.45)**	(3.21)**
Size squared	..	..	0.000	0.000	..	..	0.000	0.000
			(1.71)	(1.45)			(1.88)	(1.10)
Software	..	..	0.333	0.834	..	..	0.339	0.836
			(3.68)**	(3.96)**			(3.77)**	(4.16)**
Age	..	..	0.009	0.012	..	..	0.008	0.012
			(3.16)**	(2.27)*			(2.94)**	(1.94)
Group	..	..	−.007	1.132	..	..	−0.002	1.13
			(0.06)	(4.92)**			(0.01)	(4.76)**
North-East	−0.029	0.221	−0.007	0.270	−0.020	0.229	−0.003	0.263
	(0.22)	(0.86)	(0.05)	(0.98)	(0.18)	(0.91)	(0.02)	(0.91)
Centre	−0.457	−0.309	−0.428	−0.164	−0.443	−0.264	−0.423	−0.151
	(3.66)**	(1.00)	(3.09)**	(0.46)	(3.72)**	(1.02)	(3.28)**	(0.50)
South & Islands	−0.672	−1.457	−0.527	−1.235	−0.639	−1.435	−0.512	−1.224
	(4.66)**	(2.97)**	(3.34)**	(2.59)**	(4.48)**	(2.89)**	(4.01)**	(2.97)**
Constant	−0.127	−5.559	−0.55*	−6.909	−0.095	−5.501	−0.51	−6.72
	(0.48)	(0.73)	(−2.10)	(0.85)	(0.33)	(0.74)	(1.95)	(1.06)
Observations	3,275		3,275		3,275		3,275	
Equality test: TFP	[0.00]		[0.02]		[0.00]		[0.07]	
Equality test: R&D	..		[0.30]		..		[0.30]	
Equality test: Size	..		[0.36]		..		[0.44]	
Equality test: Software	..		[0.02]		..		[0.01]	
Equality test: Age	..		[0.47]		..		[0.55]	
Equality test: Group	..		[0.00]		..		[0.00]	
Elasticity TFP	[0.22]	[0.92]	[0.16]	[0.53]	[0.21]	[0.76]	[0.03]	[0.08]
Elasticity R&D	..	..	[0.01]	[−0.01]	..	..	[0.01]	[−0.01]
Elasticity Size	..	..	[0.05]	[0.15]	..	..	[0.05]	[0.16]
Elasticity Software	..	..	[0.02]	[0.32]	..	..	[0.02]	[0.32]
Elasticity Age	..	..	[0.05]	[0.14]	..	..	[0.05]	[0.13]
Elasticity Group	..	..	[−0.03]	[0.30]	..	..	[−0.03]	[0.30]

Note: The base category is domestic firms, (2) indicates the equation for exporters and (3) the equation for exporters and FDI. Absolute value of z statistics in parentheses (statistics based on bootstrapped standard errors, 100 replications). Two-digit industry dummies are included in all equations but not shown. Equality test is a Wald test of the null that the corresponding coefficient for the two categories is equal. Pvalues in square brackets. Elasticity is the percentage increase in probability given a 1% increase in the regressor.
* 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