Firms' Heterogeneity and Internationalisation Choices: only productivity matters? Evidence from a sample of Italian Manufacturing Firms

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a cura di ROBERTO DELLE DONNE
Prefazione di LUCIO DE GIOVANNI


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# Indice

## *Economia e società*



## *Storia e cultura*

# Firms' Heterogeneity and Internationalisation Choices: only productivity matters? Evidence from a sample of Italian Manufacturing Firms*

Luigi Benfratello**
Tiziano Razzolini***

*Abstract*: This paper provides evidence on the relative importance of productivity and other firm-level characteristics in affecting firms' internationalisation choices. By using detailed qualitative and quantitative information for a large sample of both large and small-medium sized Italian companies we identify firms engaged in international activities through exports and/or horizontal FDIs and estimate different measures of Total Factor Productivity (TFP). This allows us to provide further empirical support to the theoretical prediction of a productivity ranking among domestic firms, exporters, and multinational firms (MNEs). We then estimate multinomial logit models with both TFP and other firm-level characteristics (size, innovative activity, age, ICT adoption, labour composition, group membership, and location in an industrial district) as regressors in order to shed some light on the interplay of all these variables in affecting firms' globalisation choices. We find that i) productivity remains an important driver of globalisation choices although the inclusion of additional firm-level characteristics (notably size, innovative activity, and labour composition) lowers its impact; ii) the other covariates appear to have a direct effect (i.e: not through productivity) on globalisation. These findings support the idea that old and new theories highlight different – only partially overlapping – factors affecting firms' choice to expand their activities abroad.
*Keywords*: FDI, Productivity, Export, Firm Heterogeneity, Multinomial Logit
*JEL Classification*: F14, F23

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## 1. *Introduction*

Twenty years of applied research in international trade have ascertained the existence of a striking intra-industry heterogeneity in firms' international engagement. Even within narrowly defined industries some firms serve only the domestic market, others also export into foreign countries, while others own production plants abroad.

Faced with this evidence, theoretical literature has only recently elaborated formal models in which key drivers of internationalisation choices are not industry characteristics (such as transport costs and trade barriers) but the heterogeneity in firms' productivity. These new theories are based on the assumption that both export and production abroad entail some additional fixed costs with respect to domestic production (e.g. those linked to market researches, setting up of new distribution channels, and duplication of domestic plants). Fixed costs are higher for setting up production facilities abroad than for exporting but foreign production allows the firm to save on transportation costs. As a consequence, the theory predicts that only the most productive firms are able to afford these higher costs to become multinationals, firms with intermediate level of productivity export whereas the least productive firms serve only the domestic market.

This ranking of productivity according to firms' internationalisation modes has already been tested by several papers. Overall, the empirical evidence tends to confirm the alleged ranking especially for the comparison between FDI and exporters. However, some unresolved issues still remain. Part of this literature uses datasets mostly composed of large firms so that results are biased against finding significant productivity differences. Furthermore, although these theoretical predictions mainly refer to horizontal FDI (i.e. production of finite good sold locally) and not to vertical FDI, empirical analyses often face awkward difficulties to ascertain the kind of activity performed abroad. Finally, apart from some very recent exceptions[1], models assume that the unique firm-level variable affecting internationalisation choices is an exogenously given productivity advantage. Therefore, most of the applied literature fails to consider other characteristics (e.g. R&D intensity, age, and so forth) identified by previous empirical literature as drivers of firms' choice to export and/or to become a multinational enterprise (MNE, henceforth).

[1] E.g. B. Y. Aw - M. J. Roberts - D. Y. Xu, *R&D*.

The aim of this paper is twofold. The first one is to provide additional evidence on the alleged ranking in productivity with new data. The second, and more important one, is to assess the relative importance of productivity and other firm-level characteristics in explaining globalisation choices. As for the first aim, we provide further evidence on the links between productivity and the decision of exporting and/or undertaking horizontal FDI for a large sample of both large and small-medium sized Italian manufacturing firms, more representative of the population of Italian firms than previously used samples. The database contains standard balance sheet data, information on several firm characteristics (e.g. age, innovative activities) as well as detailed information on firms' global engagement. This allows us to identify – among MNEs – those performing horizontal FDIs, the kind of FDI for which theory suggests the productivity ranking. To assess whether this ranking occurs, we estimate production functions at the industry level to compute firms' measures of Total Factor Productivity (TFP, henceforth) and we compare the distribution of productivity for each category (domestic, exporters, exporters and FDI performers) through non parametric tests of stochastic dominance. As for the second aim, we assess the links between "new" and "old" theories of internationalisation. New theories assume that productivity is the only driver of internationalisation choices. A more traditional view neglects productivity but considers other determinants of internationalisation choices: innovative activity, investments in ICT, age, size, group membership, labour composition, localisation in industrial districts. As some of these variables are clearly correlated with productivity, it is interesting to assess whether the effect of productivity remains after controlling for these variables or – conversely – whether these variables have an effect on internationalisation choices which does not run through the productivity channel. To this end, we use TFP and the other "classical" determinants of firms' internationalisation decision as regressors in multinomial logit models.

Our results can be summarised as follows. We do confirm the ranking of productivity predicted by theoretical models. Non parametric tests show that MNEs display higher TFP levels than exporters, which in turn are more productive than firms serving only the domestic market. The econometric analysis based on multinomial choice models including only productivity and geographical and industry dummies also confirms these theoretical predictions. Second, the inclusion of other determinants of multinationalisation choice partially captures the impact of TFP but its

effect remains significant. Overall, the significance of both TFP measures and other firm-level variables shows that productivity is not the only driver of internationalisation and that other firm-level variables exert an impact on internationalisation through channels different from productivity.

The paper is organised as follows. The next section reviews the main theoretical contributions on heterogeneity and internationalisation choices and the received empirical evidence, thereby motivating our paper. Section 3 describes our dataset whereas section 4 presents both 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 the key determinant of firms' internationalisation choice.

Models of industry dynamics[2], which provide a useful theoretical framework that relates firm decision to entry or exit from a market with its productivity level, 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. This prediction has been empirically tested on large datasets at the firm-level. A host of studies, pioneered by Aw and Hwang and Bernard and Jensen[3], 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.[4]

[2] E.g. H. Hopenhayn, *Entry*.

[3] B. Y. Aw - A. R. Hwang, *Productivity*; A.B. Bernard - B.J. Jensen, *Exporters*.

[4] See for instance S.K. Clerides - S. Lach - J.R. Tybout, *Is Learning*; A.B. Bernard - B.J. Jensen, *Exceptional*; M.A. Delgado - J.C. Fariñas - S. Ruano, *Firm*. Surveys on the findings of the literature relating exports and

More recent studies extend the analysis by focusing on horizontal FDI as alternative to export in serving foreign markets. Brainards's theoretical models using representative firms[5] show that the choice between horizontal FDI and export is driven by the so-called proximity concentration trade-off. Production abroad 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, and Head and Ries[6] extend the Brainard model by showing that firms' heterogeneity in productivity drives the choice between export and horizontal FDI. 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 become MNEs. However, these models assume that home and host countries display the same cost level, so that vertical FDI are ruled out. Once lower costs in the host countries are allowed, as in the extended version of the Head and Ries model[7], the productivity ranking can be reversed, the least productive firms performing cost-saving FDIs. [8]

Only a limited number of papers, surveyed by Greenaway and Kneller[9], has tested the productivity ranking: Girma, Görg and Strobl for Ireland, Girma, Kneller and Pisu for the UK, Castellani and Zanfei for Italy, Arnold and Hussinger and Wagner for Germany, Kimura and Kiyota for Japan.[10] 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

productivity are D. Greenaway - R. Kneller, *Firm*, J. Wagner, *Exports and Productivity*, and D. Castellani - A. Zanfei, *Multinational*, ch. 3. See also A.B. Bernard - B.J. Jensen - S.J. Redding - S.J. Schott, *The Empirics* for a broader empirical survey on the heterogeneous firms in international trade literature.

[5] See S.L. Brainard, *A Simple* and S.L. Brainard, *An Empirical*.

[6] E. Helpman, - M.J. Melitz - S.R. Yeaple, *Export*; K. Head - J. Ries, *Heterogeneity*.

[7] K. Head - J. Ries, *Exporting*.

[8] G. Grossman - E. Helpman - A. Szeidl, *Optimal* analyse vertical FDIs as part of more complex FDI strategies where firms can freely choose where to locate two production stages. In this model the ranking in productivity depends on several parameters (fixed cost of FDI, transport costs and sizes of the markets), so that no univocal ranking emerges.

[9] D. Greenaway - R. Kneller, *ibid*.

[10] S. Girma - H. Görg, - E. Strobl, *Exports*; S. Girma - R. Kneller - M. Pisu, *Exports*; D. Castellani - A. Zanfei, *Internationalisation*; J. Arnold - K. Hussinger, *Export;* J. Wagner, *Exports, foreign*; F. Kimura - K. Kiyota, *Exports*.

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 MNEs and exporters whereas less clear results are obtained in the exporters vs. non exporters comparison.[11]

The difficulty in finding detailed information on both export and multinational activities explains not only the low number of analyses on the issue but also some potential drawbacks these analyses might suffer from. As pointed out by Greeneway and Kneller[12], in fact, some samples are biased towards large firms and therefore against finding significant productivity differences. Furthermore, theoretical predictions mainly refers to horizontal FDI and not to vertical ones, but precise information on the activity performed abroad is hard to find. Capital stock is often lacking in the data, leading to the use of labour productivity, a partial productivity measure less reliable than TFP. Finally, papers using 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. As a matter of fact, productivity is the result of firms' strategies, such as investment in fixed capital, in R&D and in workers' human capital. These variables might also exert an impact on internationalisation choice through channels different from the productivity ones. For instance, R&D enhance productivity but might also foster firms' market positions by spurring product innovation. The joint consideration of both productivity and other firm-level variables in affecting globalisation choices is therefore in order.

The only authors addressing this issue are Kimura and Kiyota on the one hand and Castellani and Zanfei on the other[13]. They control whether the higher productivity of multinational firms (MNEs, henceforth) and exporters is robust to the inclusion of firm-level covariates. Kimura and Kiyota control for 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 discuss their expected impact

[11] 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 (on this, see the references in footnote 4).
[12] D. Greenaway - R. Kneller, *ibid.*
[13] F. Kimura - K. Kiyota, *ibid*; D. Castellani - A. Zanfei, *Internationalisation.*

nor present the estimated coefficient. Castellani and Zanfei, instead, explicitly explain the productivity advantage in the light of superior technological knowledge possessed by MNEs. They refer to the eclectic paradigm framework – put forth by Hymer and Dunning[14] and 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 regress estimated TFP on dummy variables for each category while using additional regressors which control for firms' 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, as well as size and location dummies. They find that technological intensity variables explain most of the higher productivity of MNEs with respect to exporters and domestic firms.[15]

We contribute to this scant literature along several directions. Firstly, we provide additional evidence on the alleged superior productivity of exporters and FDI firms using Italian data. This evidence supplements the one provided by Castellani and Zanfei using a small dataset, mostly composed of large firms. Instead, we use a much larger dataset composed also by small-medium sized firms so that it is less prone to size bias, includes a richer set of covariates, and focuses on horizontal FDIs only. Secondly, and more importantly, we simultaneously measure the impact of several factors, alongside with productivity, on firms' globalisation choices. In doing so, we give a proper econometric structure to firms' choices by estimating a multinomial logit model.[16] We exploit the richness of our dataset and include a large set of additional variables which might explain the choice between export and horizontal FDI. A first set is composed of variables representing 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

[14] S. Hymer, *The international*; J.H. Dunning, *Studies*.

[15] The explanation of MNEs' higher productivity in the light of their superior technological capabilities has been put forth also by C. Criscuolo - J.E. Haskel - M. Slaughter, *Global*. 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.

[16] In this light, our paper is similar in spirit to R. Basile - A. Giunta - J. Nugent, *The Foreign* 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.

formal R&D activity but introduce innovations through acquisition of patents and/or of new production processes or through informal acquisition of technological knowledge. Therefore, we include variables related with both the input (R&D intensity, measured as R&D expenditures over turnover) and the output (dummies for the introduction of product and process innovations) of the innovative activity. We also use a measure of ICT adoption as regressor. On the one hand, a large body of empirical literature has highlighted the correlation between ICT and productivity[17]. On the other hand, it might be argued that improved monitoring ability from ICT promotes delegation of authorities[18] and ICT adoption reduces the transaction and monitoring costs of moving activities outside the firms and carrying them out at greater geographical distance[19]. We also draw from previous literature[20] which has identified size, age, group membership and localisation in industrial districts 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. Group membership might provide firms with the necessary marketing and financial resources to internationalise whereas localisation in Marshallian districts might offer firms economies of scale in the provision of export services and exchange of information about foreign markets[21]. 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.

## 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 2001-2003 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

[17] For a recent survey, see M. Draca - R. Sadun - J. Van Reenen, *Productivity*.
[18] M. Del Mastro - M. Colombo, *Delegation*.
[19] L. Abramovsky - R. Griffith, *Outsourcing*.
[20] E.g. A. Sterlacchini, *Do innovative*.
[21] L. Becchetti - S.P.S. Rossi, *The Positive*.

than 500 employees are selected on the basis of a stratified sample, so that small and medium sized firms are well represented.[22]

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 year 2003 (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). More specifically, we rely on the final destination of the output produced in the foreign plant and we consider a firm as performing a horizontal FDI if the majority of this production is sold as a final product and not reimported in Italy as an intermediate input.[23] Therefore, we are able to distinguish three categories of firms: domestic firms (producing and selling exclusively in Italy), exporters, and exporters which also perform 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).[24]

We used firms' balance sheet data to estimate production functions and to compute TFP. To this end, we performed standard cleaning pro-

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

[23] See the Data Appendix for more details. We are aware that our classification is only a proxy for horizontal FDI. In fact, the FDI firms category might contain firms with contracts with foreign producers, i.e. foreign outsourcers. However, theoretical predictions and empirical analyses (E. Tomiura, *Foreign*) suggest that foreign outsourcers should lie — in terms of productivity — between domestic and 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. Furthermore, our sample includes export platform FDI: although they are not — strictly speaking — horizontal FDI, they save on transportation cost and require the setting up of production facilities abroad so that — for the purpose of this paper — they follow the same logic than horizontal FDI. Nonetheless, we performed a robustness check of our results with respect to the definition of FDI category (see footnote 38). Finally, by focusing on delocalised production previously performed at home, we select as FDI those activities related to firm's core business, thereby excluding unrelated FDI.

[24] In the original sample only 12 firms were involved in horizontal FDI without exporting. As most 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.

cedures. 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, 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, localisation in Marshallian districts).

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 (proxied by a dummy equal to 1if 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.[25] Domestic firms appear to be younger than globalised firms whereas the latter seem to locate in industrial districts more than domestic firms do. 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:

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

[25] We use only one available proxy for ICT adoption, the others being whether the firm invested in hardware and in telecommunications, because of multicollinearity among these different regressors.

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 $\eta_{it}$ is a time-varying error component (idiosyncratic shock).[26]

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 henceforth) or the Levinsohn and Petrin approach (LP henceforth).[27] 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, a refinement of the seminal work of Olley and Pakes[28]. 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 individual effect; for the LP approach we compute TFP by averaging by firm the estimated residuals and dividing by the industry mean value of TFP.[29]

Table 1 shows mean and standard deviation of the TFP estimated by the FE and the LP procedures by internationalisation choice. The two methods yield, rather comfortingly, very similar measures of TFP. Most

[26] See the Data Appendix for inputs and output definition.

[27] J. Levinsohn - A Petrin, *Estimating*. 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).

[28] G.S. Olley - A. Pakes, *The Dynamics*.

[29] 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 A. Petrin - B.P. Poi - J. Levinsohn, *Production*). Notice that in the LP procedure the $v_i$ term in equation (1) is replaced by $\omega_{it}$, a transmitted productivity component. See Table A.5 for capital and labour elasticities estimates across the different industries.

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.

Table 1: Descriptive statistics, TFP indexes

| | *Fixed Effects* | *Levinsohn and Petrin* |
|---|---|---|
| Domestic | 0.94(0.38) | 0.90(0.33) |
| Exporters | 1.07(0.41) | 1.00(0.35) |
| Exporters and FDI | 1.21(0.42) | 1.14(0.34) |

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

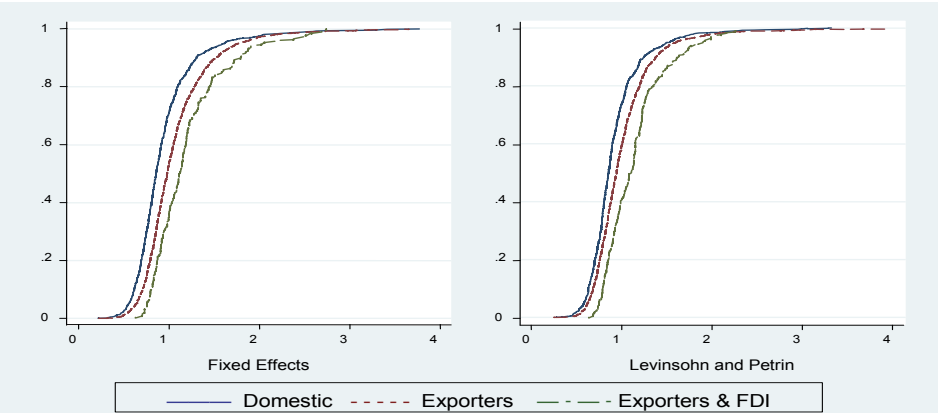
This ranking in the mean value of TFP across categories is fostered by graphic comparison of the three cumulative distributions of TFP (see Graph 1). Regardless of the estimation method, the productivity distribution for MNEs always lies below (and to the right) of the distribution for exporters which in turn lies below the one for domestic firms. We also perform statistical tests of first order stochastic dominance through Kolmogorov-Smirnov (K-S, henceforth) tests[30]. Following Delgado, Fariñas and Ruano[31] we perform tests of stochastic dominance of a given distribution $F(z)$ (in our case, the productivity distribution of FDI firms) with respect to another distribution $G(z)$ (in our case, the productivity distribution of domestic firms) by testing two hypotheses:

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

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 $G(z)$.

[30] 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 $z$.
[31] M.A. Delgado - J.C. Fariñas - S. Ruano, *ibid.*

**Graph 1**: Cumulative distribution of TFP estimated with Fixed Effects and the Levinsohn and Petrin approach, by internationalisation mode




For each couple of categories (domestic vs. exporters, domestic vs. FDI, exporters vs. exporters and FDI) 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.

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

| | *Fixed Effects* | | *Levinsohn and Petrin* | |
|---|---|---|---|---|
| | Two sided | One sided | Two sided | One sided |
| Domestic vs Exporters | 0.204(0.000) | -0.003(0.993) | 0.195(0.000) | -0.001(0.997) |
| Domestic vs Exporters and FDI | 0.374(0.000) | -0.007(0.987) | 0.363(0.000) | -0.010(0.977) |
| Exporters vs Exporters and FDI | 0.209(0.000) | -0.008(0.981) | 0.230(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 null that the cumulative distribution function of the second group lies below (or is equal to) the cumulative distribution function of the first group against the alternative that it lies above. All tests are run on the sample of 3,275 firm-level means used as regressor in the multinomial choice equations.

## 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. This unconditional comparison of productivity closely follows recent theoretical models which identify productivity as the only driver of firms' globalisation choices, but neglects other sources of firms' heterogeneity (e.g. size, age, and technological intensity) which have traditionally played an important role in the internationalisation theory of the firm. In this section we adopt a different approach by estimating multinomial logit models where the polychotomous dependent variable is the internationalisation choice (the three categories of no internationalisation, export, export and FDI), modelled as function of productivity and traditional determinants of exporting and/or performing FDI. This strategy allows us to give an appropriate econometric structure to the choice faced by firms and to estimate the separate impact of productivity and traditional determinants on the probability of choosing one of the internationalisation options. Furthermore, it also allows us to jointly assess the interplay of all these covariates in driving firms' decisions.

Table 3 shows the results of five multinomial logit models. They differ either in the regressors (model (*i*) includes only traditional determinants, models (*ii*) and (*iii*) only TFP, models (*iv*) and (*v*) both sets of regressors) or in the way TFP is measured (FE in models (*ii*) and (*iv*), LP in models (*iii*) and (*v*)). 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.[32]

[32] 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 J.M. Wooldridge, *Econometric*).

Table 3: Estimates of the Multinomial Logit model

| *Model* | *(i)* NO TFP | | *(ii)* FE base | | *(iii)* LP base | | *(iv)* FE full | | *(v)* LP full | |
|---|---|---|---|---|---|---|---|---|---|---|
| *Dep variable Category* | (2) | (3) | (2) | (3) | (2) | (3) | (2) | (3) | (2) | (3) |
| *TFP* | .. | .. | 1.192*** | 1.793*** | 1.314*** | 2.045*** | 0.769*** | 1.017*** | 0.762*** | 0.863** |
| | .. | .. | (5.11) | (5.65) | (6.61) | (6.50) | (3.90) | (3.61) | (4.01) | (2.50) |
| *R&D* | 0.073* | 0.005 | .. | .. | .. | .. | 0.083* | 0.019 | 0.081* | 0.015 |
| | (1.93) | (0.08) | .. | .. | .. | .. | (1.74) | (0.31) | (1.88) | (0.25) |
| *Size* | 0.006*** | 0.007*** | .. | .. | .. | .. | 0.004*** | 0.006*** | 0.005*** | 0.006*** |
| | (6.79) | (6.80) | .. | .. | .. | .. | (3.13) | (3.14) | (4.21) | (3.05) |
| *Size squared* | -0.000*** | -0.000*** | .. | .. | .. | .. | -0.000** | -0.000 | -0.000** | -0.000 |
| | (-5.68) | (-5.46) | .. | .. | .. | .. | (-1.98) | (-1.46) | (-2.38) | (-1.05) |
| *Software* | 0.235** | 0.730*** | .. | .. | .. | .. | 0.217** | 0.716*** | 0.222** | 0.716*** |
| | (2.52) | (3.15) | .. | .. | .. | .. | (2.38) | (3.38) | (2.53) | (3.41) |
| *Age* | 0.008*** | 0.013** | .. | .. | .. | .. | 0.009*** | 0.014*** | 0.009*** | 0.013** |
| | (2.97) | (2.55) | .. | .. | .. | .. | (3.23) | (2.84) | (3.17) | (2.36) |
| *Group* | 0.080 | 1.109*** | .. | .. | .. | .. | 0.016 | 1.037*** | 0.019 | 1.040*** |
| | (0.70) | (4.83) | .. | .. | .. | .. | (0.12) | (4.66) | (0.15) | (4.34) |
| *Product inno* | 0.763*** | 0.832*** | .. | .. | .. | .. | 0.768*** | 0.827*** | 0.765*** | 0.830*** |
| | (7.33) | (3.83) | .. | .. | .. | .. | (7.51) | (3.11) | (7.65) | (3.52) |
| *Process inno* | 0.037 | 0.333 | .. | .. | .. | .. | 0.012 | 0.288 | 0.014 | 0.302 |
| | (0.39) | (1.57) | .. | .. | .. | .. | (0.13) | (1.31) | (0.14) | (1.29) |
| *Unskilled* | -0.006** | -0.024*** | .. | .. | .. | .. | -0.004 | -0.020*** | -0.004 | -0.021*** |
| | (-2.18) | (-4.54) | .. | .. | .. | .. | (-1.27) | (-3.32) | (-1.31) | (-2.88) |
| *District* | 0.370*** | -0.134 | .. | .. | .. | .. | 0.380*** | -0.129 | 0.380*** | -0.122 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (2.64) | (-0.48) | .. | .. | .. | .. | (3.01) | (-0.45) | (2.99) | (-0.44) |
| *North-East* | 0.008 | 0.305 | -0.029 | 0.221 | -0.023 | 0.227 | -0.006 | 0.305 | 0.000 | 0.301 |
| | (0.07) | (1.26) | (-0.22) | (0.86) | (-0.21) | (0.90) | (-0.05) | (1.12) | (0.00) | (1.05) |
| *Centre* | -0.391*** | -0.014 | -0.457*** | -0.308 | -0.445*** | -0.278 | -0.395*** | -0.027 | -0.388*** | -0.013 |
| | (-2.97) | (-0.05) | (-3.66) | (-1.00) | (-3.70) | (-1.08) | (-2.85) | (-0.08) | (-3.02) | (-0.04) |
| *South & Islands* | -0.418*** | -0.962** | -0.672*** | -1.457*** | -0.640*** | -1.426*** | -0.431*** | -0.978** | -0.411*** | -0.955** |
| | (-3.07) | (-2.31) | (-4.66) | (-2.97) | (-4.48) | (-2.93) | (-2.74) | (-2.01) | (-3.22) | (-2.27) |
| *Constant* | 0.412 | -4.466*** | -0.127 | -5.559 | -0.190 | -5.710 | -0.435 | -5.676 | -0.396 | -5.392 |
| | (1.62) | (-5.34) | (-0.48) | (-0.73) | (-0.76) | (-0.77) | (-1.40) | (-0.70) | (-1.20) | (-0.86) |
| Log-Likelihood | -2036.75 | | -2165.69 | | -2167.31 | | -2019.81 | | -2024.52 | |
| Pseudo $R^2$ | 0.161 | | 0.108 | | 0.107 | | 0.168 | | 0.166 | |
| *Elasticity TFP* | .. | .. | [0.248] | [0.890] | [0.257] | [0.988] | [0.173] | [0.433] | [0.171] | [0.270] |
| *Elasticity R&D* | [0.009] | [-0.039] | .. | .. | .. | .. | [0.010] | [-0.035] | [0.009] | [-0.037] |
| *Elasticity Size* | [0.052] | [0.179] | .. | .. | .. | .. | [0.040] | [0.157] | [0.040] | [0.162] |
| *Elasticity Age* | [0.042] | [0.170] | .. | .. | .. | .. | [0.047] | [0.183] | [0.046] | [0.175] |
| *Elasticity Skilled* | [-0.057] | [-1.247] | .. | .. | .. | .. | [-0.027] | [-1.125] | [-0.024] | [-1.179] |

**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. z statistics in round brackets (statistics based on bootstrapped standard errors, 100 replications for models *(ii)* to *(v)*). Two digit industry dummies are included in all equations but not shown. Elasticity $\left[\frac{dP/P}{dx/x} \text{ where } \frac{dP}{dX} = P_j\left(\beta_j - \sum_{i=1}^{K} \beta_k P_k\right)\right]$ 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 10%; ** significant at 5%; *** significant at 1%.

Model (*i*) includes only traditional determinants of globalisation choices: size, age, R&D intensity, labour force composition (percentage of blue collar workers over total number of employees), dummies for ICT adoption (investment in software), product and process innovations, group membership, and localisation in industrial districts. Following previous literature which finds a U-shaped relationship between size and export[33] 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.

In line with our a priori, size positively and significantly affects the decision to expand abroad, at a decreasing rate (the linear term being positive and the quadratic one negative). The elasticity is positive for both categories and more than three times larger for MNEs than for exporters.[34] Likewise, age plays a positive role in globalisation activities as older firms seems to internationalise more than younger ones. Group membership exerts a positive influence only on the decision to perform FDI whereas localisation in an industrial district affects only the probability to export. ICT adoption affects both decisions, but more significantly so for the FDI choice. As for innovative activity, mixed results emerge. At the input level, R&D intensity seems to play a marginally positive role only for exporters but not for MNEs. 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 very marginally significant. Overall, these results tend to confirm the previous evidence that innovative activity is an important determinant of both export and FDI decisions[35]. The estimates of the labour composition variable show that both MNEs and exporters are more skilled intensive than domestic firms. This result might be explained in the light of some non production activities performed by globalised firms, such as marketing in foreign markets and coordination tasks with subsidiaries. The coefficient of the dummy for ICT investment is positive and very significant in both equations. Finally, coefficients for

[33] E.g. A. Sterlacchini, *ibid.*

[34] 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.

[35] See among others S. Barrios - H. Görg - E. Strobl, *Explaining* and B. Y. Aw - M. J. Roberts - T. Winston, *Export* for export and D. Castellani - A. Zanfei, *Internationalisation* for MNEs.

Centre and South & Islands area dummies are negative and significant (the Centre for export only), confirming the well known difficulties that firms located in these macro areas have to face in order to internationalise.[36]

Models (*ii*) and (*iii*) include only TFP, alongside with area and industry dummies, as regressor. As expected, the coefficient of TFP is positive and highly significant for both categories and both models. In line with theoretical predictions, the elasticities of estimated probabilities with respect to TFP are higher for export and FDI than for export only. The effect of TFP is sizeable: increasing TFP from the $10^{th}$ percentile of its distribution to the $90^{th}$ percentile (0.69 to 1.49 for FE, 0.66 to 1.36 for LP), the probability of undertaking export and FDI almost doubles (from 0.048 to 0.080 for FE and from 0.047 to 0.085 for LP), whereas it increases much less for exporters (from 0.806 to 0.855 for FE and from 0.809 to 0.857 for LP). As before, firms located in Central and Southern regions are negative affected by their location.

Models (*iv*) and (*v*) combine previous model by including both productivity and traditional determinants of internationalisation as regressors. On the one hand, the inclusion of TFP affects only the coefficients for size, labour composition, and process innovation. More specifically, the coefficients of size sharply decrease for both categories, highlighting – as expected – a positive correlation with productivity. Nonetheless, the impact is still positive and significant, showing that an increase in size positively affects firms' globalisation activities, notably the FDI choice.[37] As for labour composition, its coefficient remains negative but it is now significant only for MNEs; as it decreases (in absolute value), the interesting result of a negative correlation between the percentage of blue collars and productivity is to be inferred. Finally, the inclusion of TFP also marginally affects process innovation, decreasing its impact. The coefficients for area dummies, ICT adoption, age, R&D intensity, group membership, location in industrial districts, and adoption of product innovation are almost unaffected. The latter results shows that once we control for productivity the development of new products (and not of new process, nor R&D itself) is the key technological driver of the ability to compete at the international level. More generally, these findings show that the effect of these covariates on internationalisation choices goes beyond

[36] On the issue of geographical differences in exporting behaviour of Italian firms, see R. Basile, *Export*.

[37] Size is sometimes used as proxy for productivity: our findings show that size exerts an impact on globalisation choices which goes beyond its effect on productivity.

the effect on productivity, so that they operate through different channels. For instance, the effect of ICT adoption might lower monitoring and coordination costs induced by delegation of authority to a foreign plant and location in industrial district might lower the cost of acquiring information on foreign markets.

On the other hand, the estimated coefficients for TFP and the elasticities of the estimated probabilities are lower in models (*iv*) and (*v*) than those obtained in base models (*ii*) and (*iii*), the decrease being sharper in the LP approach and notably for the FDI category. Increasing productivity by 1% increases now the probability of exporting by 0.17% and the one of performing FDI by around 0.3-0.4%. These findings highlight that productivity is correlated with some of these additional regressors, so that they partially explain its impact on the dependent variables. However, the estimated coefficients are statistically significant for both categories in models (*iv*) and (*v*) so that productivity plays a role in globalisation decisions that is not captured by other firm observable characteristics.[38]

## 6. *Final remarks*

Two different sets of variables have been highlighted by literature in international trade as determinants of firms' internationalisation choices. A traditional stream has indicated some variables that either lower the uncertainty entailed by operating in foreign markets or lead to scope economies to be exploited abroad (such as superior technological knowledge, size, and age). Recent theoretical models have instead emphasized the importance of heterogeneity in productivity, in turn predicting a ranking in productivity vindicated – so far – only by some papers. Apart from very few exceptions, both set of covariates has not been jointly used, so that their relative importance has not been ascertained.

[38] 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 LP 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 7.2 in the Data Appendix) to select in the export and FDI category only those firms explicitly stating that delocalisation was driven by proximity, the key motivation for horizontal FDI. 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.

Therefore, two empirical questions arise: the first one is whether productivity matters for globalisation choices; the second one is whether other firm-level determinants contribute alongside with productivity to explain internationalisation choices. To address the first question, we perform simple comparison of TFP distributions across categories of firms. To address the second one, we estimate multinomial regression models in which the type of engagement in international markets is first separately and then jointly explained by productivity and other firm-level attributes. 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, industry, and geographical dummies. By including traditional drivers of internationalisation as regressors we are then able to depict how exporters and MNEs differ with respect to domestic firms. 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 and to be located in industrial districts. When we jointly consider productivity and other heterogeneity attributes in multinomial models, both traditional variables and productivity appear to be important drivers. The coefficients of the TFP variable decrease in value but are still significant. More specifically, TFP appears to be correlated with size, labour composition, and technological intensity. This finding suggests that productivity and other firm attributes explain different, although partially overlapping, mechanism leading firms to expand abroad.

Finally, we are aware that our paper, like most literature on this issue, is able only to detect correlation among the variables and not to identify the causality links between productivity, other firms' characteristics, and internationalization modes. Only a dataset spanning a longer time period could provide us the dynamics in the variables necessary to model causal

relationships and overcome this limitation.[39] In the meanwhile, our findings provide a first evidence – although static – on the interplay of firm-level characteristics and productivity for firms' decision to export and engage in FDI.

[39] Dynamic approaches to jointly modelling productivity and firm choices to export and invest in R&D have been adopted in B. Y. Aw - M. J. Roberts - T. Winston, *Export* and B. Y. Aw - M. J. Roberts - D. Y. Xu, *ibid*.

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# 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 is run on 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. We use this sample, composed of 3,562 firms, 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 9th 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 not contain detailed information on delocalization preventing us to identify whether firms change their state over time.

D3.1 At present the firm performs abroad part of his production previously performed at home?
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 (unskilled): average number of blue collars over average total number of employees, in percentage.

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.

Industrial district: dummy variable, 1 if the firm is located in an industrial district (as identified by F. Sforzi, *I distretti* and ISTAT, *I sistemi*) and firm's main activity is the same as that characterising the district, 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; 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 | 7 |
| 32 – Electronic material | 70 | 64 | |
| 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 Effects* | | *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* | *Age* | *Unskilled* | *Software* | *Group* | *Product* | *Process* | *District* |
|---|---|---|---|---|---|---|---|---|---|
| *Domestic (838)* | | | | | | | | | |
| Mean | 0.32 | 54.26 | 24.55 | 69.56 | 0.48 | 0.21 | 0.24 | 0.39 | 0.11 |
| Sd | 1.28 | 96.73 | 16.28 | 19.91 | .. | .. | .. | .. | .. |
| Min | 0 | 7.33 | 0 | 0 | .. | .. | .. | .. | .. |
| Max | 13.84 | 1604.33 | 143 | 100 | .. | .. | .. | .. | .. |
| *Exporters (2,286)* | | | | | | | | | |
| Mean | 0.82 | 101.08 | 27.94 | 66.78 | 0.62 | 0.30 | 0.49 | 0.49 | 0.19 |
| Sd | 2.44 | 163.26 | 19.47 | 17.60 | .. | .. | .. | .. | .. |
| Min | 0 | 10.33 | 0 | 0 | .. | .. | .. | .. | .. |
| Max | 54.68 | 2793.66 | 190 | 100 | .. | .. | .. | .. | .. |
| *Exporters and FDI (151)* | | | | | | | | | |
| Mean | 0.92 | 215.86 | 28.63 | 59.05 | 0.77 | 0.58 | 0.58 | 0.60 | 0.17 |
| Sd | 1.55 | 368.46 | 20.19 | 21.00 | .. | .. | .. | .. | .. |
| Min | 0 | 10.33 | 2 | 0 | .. | .. | .. | .. | .. |
| Max | 7.91 | 2862 | 129 | 94.31 | .. | .. | .. | .. | .. |
| ***Total (3,275)*** | | | | | | | | | |
| Mean | 0.69 | 94.40 | 27.10 | 67.13 | 0.60 | 0.29 | 0.43 | 0.47 | 0.17 |
| Sd | 2.17 | 168.34 | 18.79 | 18.50 | .. | .. | .. | .. | .. |
| Min | 0 | 7.33 | 0 | 0 | .. | .. | .. | .. | .. |
| Max | 54.68 | 2862 | 190 | 100 | .. | .. | .. | .. | .. |

**Note**: Regressors are defined in Section 7.3. In round brackets the number of firms belonging to that category. For dummy variables the mean represents the proportion of observations equal to 1

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