

## A MULTIVARIATE FRAMEWORK TO EXPLORE FIRMS' INTERNATIONALIZATION PATTERNS: THE ROLE OF INDIVIDUAL HETEROGENEITY

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### 1. INTRODUCTION

In recent years, globalization has engendered a remarkable expansion of firms across national borders as international trade and foreign direct investments have become among the fastest growing economic activities the world over. These changes have affected the nature and modes of firm international involvement, and consequently have produced new developments in the theory of the international trade and foreign investment.

Until the 1990s, trade theory asserted that firms in the same industry or country adopt very similar behaviour in terms of international involvement. In 1995, Bernard and Jensen published a pioneering empirical research demonstrating that within the same industry, exporting firms differ from non-exporting ones in terms of various performance indicators, including productivity (Bernard and Jensen, 1995). Melitz (2003) proposed a theoretical model with heterogeneous firms that considered the interaction between productivity of firms in the same industry and exports. Helpman *et al.* (2004) extended the Melitz model to include, besides exports, horizontal foreign direct investments (hereafter FDI). In the last decade, a number of studies have focused on the interaction between internationalization and firms' heterogeneity. The main result emerging is that productivity is positively related with firms' international involvement and that the choices in internationalization are in turn linked to sunk costs (for a complete and up to date review see Greenaway and Kneller, 2007, and Helpman, 2006).

To the best of our knowledge, most of these studies neglected the fact that other strategies of international engagement, besides exports and FDI, have gained rapidly in importance in the world economy; lack of detailed individual information may have contributed to this deficiency. Exceptions are the paper by Basile *et al.* (2003) that considers also commercial penetration operations and the paper by Castellani and Zanfei (2007) that takes into account the establishment of non-manufacturing activities abroad.

Moreover, studies that focus on the relationship between modes of internationalization and firms' heterogeneity mostly link the variables capturing this last

dimension to productivity. However, recent literature has stressed that foreign expansion could be connected to other characteristics of firms that maybe related to productivity, such as innovative behaviour, proprietary assets, skills composition, organizational choices, accumulation of technology and so on (Castellani and Zanfei, 2007; Helpman, 2006).

This paper contributes to the debate on the interaction between modes of internationalization and heterogeneity at least in two areas.

Firstly, we consider a larger range of internationalization forms including non-equity ones like commercial penetration, agreements, and offshoring of production, besides the usual exports and FDI. This framework would represent the behaviour of firms operating in the real world where other intermediate forms of foreign expansion have to be considered as valuable alternatives to the polar ones.

Secondly, we analyze the complexity of the internationalization dimension in a multivariate framework that takes into account the associations among the choices driving firm internationalization strategy as a whole. To this end, we use a Multivariate Probit model (MVP) that gives us a number of advantages compared to other discrete choice models already in use in the literature. More in detail to the best of our knowledge, the literature on firms' internationalization generally models the association between different forms of internationalization by formulating some *a priori* assumptions. Benfratello and Razzolini (2008) adopt a multinomial logit model for the categories of "no internationalization", "only export" and "export plus horizontal FDI". In this way, they disregard one possible outcome ("only FDI"). Basile *et al.* (2003) propose an internationalization index that considers "export", "export and commercial penetration" and "export, commercial penetration, and FDI" besides the "no internationalization" category. This implies a decision that excludes the combinations of some internationalization modes (for example of "export and FDI"). The authors fit to this index a univariate ordered probit thereby assuming that the categories considered are ordered and that the internationalization process is cumulative. In other words, both models require an *a priori* definition of all the possible combinations of the internationalization modes and/or to impose an *a priori* choice of the structure of internationalization patterns. Note that the number of these combinations increases with the number of internationalization modes considered, becoming quickly intractable as it exceeds three.

The MVP allows the analysis of the internationalization patterns in a multivariate framework. In this model, every internationalization mode corresponds to a binary choice (*yes/no*), depending on some function of covariates specified through different equations, but allows simultaneity of choices of internationalization. This structure prevents us from specifying *a priori* all the possible patterns of internationalization or making specific assumptions on the process of internationalization.

Consequently, in this paper, we do not test the hypothesis of the cumulative nature of the internationalization versus the substitutive assumption but we consider all the possible internationalization patterns. Based on the idea that simulta-

neity of different internationalization modes can be analyzed in depth only by considering all possible combinations of them, we draw from our estimates the information on how the different internationalization categories associate and how these patterns combine with the various dimensions of firms' heterogeneity. Associations are modelled through correlations informing us how different internationalization modes combine to constitute the overall foreign expansion strategy of the firm.

Note that we do not use the MVP regression model with the aim to infer causal dependence of internationalization choices from the covariates, but as an inferential tool that allows the detection of relevant relationships between internationalization patterns and the variables describing firms' heterogeneity. Multivariate descriptive statistical instruments not relying on functional forms are not apt to identify significant connections.

At the end, we use a large range of covariates besides Total Factor Productivity (TFP) to describe the heterogeneity of firms. Therefore, the MVP presents further advantages over the other discrete choice models because a different set of covariates can be used for each category considered. This allows us to test whether the same covariates affect each internationalization mode differently. We rely for our analysis on the data provided by the Capitalia<sup>1</sup> survey, a very rich micro-level dataset on Italian manufacturing firms where information on the different forms of international involvement are collected.

The paper is organized as follows: in Section 2 we give a review of the literature on the international involvement of firms. Section 3 contains a description of the data used and some descriptive statistics. The MVP is presented in Section 4. In Section 5, we report and comment on the results of model estimation. Section 6 concludes.

## 2. INTERNATIONAL INVOLVEMENT OF FIRMS: A REVIEW OF THE THEORETICAL AND EMPIRICAL LITERATURE

### 2.1 *The role of firm heterogeneity*

In this section, we give a brief review of the literature on the firms' dimensions related to international activity<sup>2</sup>. Traditional theories of international trade explain the international involvement of firms in terms of the so-called proximity–concentration trade-off (Brainard, 1997). The idea is that firms concentrate the production at home serving foreign markets via exports if there are advantages to concentration. On the other hand, they are more likely to establish foreign production facilities when the transport costs are higher and trade barriers exist, the fixed costs of entry are lower, and the economies of scale can be realized at the plant level. In this form of FDI, called horizontal FDI, firms produce abroad the

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<sup>1</sup> Capitalia was one of the largest Italian banks; recently the Unicredit group has acquired it.

<sup>2</sup> For a comprehensive review on this subject see Castellani and Zanfei (2007), Greenaway and Kneller (2007), Helpman (2006), Markusen (2002), and Wagner (2007).

same products they produce at home. Subsequently, general equilibrium models have been extended to include vertical FDI, an internationalization form that arise when the firm locates each stage of production in the country where it can reduce overall production costs (Markusen, 2002). Hence, in general it produces abroad products different from those that it produces at home. An implication of this theory briefly outlined is the assumption of a representative firm within each industry of each country. In this framework, firms' advantages, market structure, and production and transaction costs are sector-specific and/or country-specific. The model assumes symmetry across firms within an industry in terms of available technology. This suggests that firms characterized by similar productivity levels adopt the same behaviour in terms of participation in foreign trade. However, in the real world firms internationally involved are not a random sample of the firms' population in an industry. Exporting and non-exporting firms coexist in the same industry, and in a single industry, only a small fraction of firms realizes FDI.

The heterogeneous firms' model faces these drawbacks, relating decisions of firms to their productivity levels. In his pioneering paper, Melitz (2003) builds a dynamic theoretical industry model that considers the interaction between productivity differentials across firms in the same industry and the fixed costs of exporting. Helpman *et al.* (2004) extend the Melitz model combining the analysis of exports to that of (horizontal) FDI. The paper focuses on the role of intra-industry firm productivity differentials in explaining the structure of international trade and investment. The model highlights that only the most productive firms engage in foreign activity and that among firms that serve the foreign market only the most productive engage in FDI. The authors also confirm the proximity-concentration trade-off: firms tend to substitute FDI for exports when transport costs are larger and economies of scale are small. In short, these results suggest that heterogeneity in productivity is a potential source of comparative advantage.

Several empirical studies that test the relationship between firms' heterogeneity and internationalization modes has stemmed from this stream of literature. An extensive stream of literature shows that the most productive firms undergo a self-selection process to enter export markets (among others see Head and Ries, 2003, Helpman *et al.*, 2004, Girma *et al.*, 2004, Girma *et al.*, 2005). On the assumption that productivity affects internationalization choices, they substantiate a ranking of firms' performance indicators and productivity across multinationals, exporters, and firms serving only domestic markets. Few contributions test the *learning-by-exporting* hypothesis showing that firms gain productivity advantages only after they start exporting (Kraay, 1999; Castellani, 2002a; Girma *et al.*, 2002; Crespi *et al.*, 2008). Aw *et al.* (2000) and Castellani (2002b), however, present evidence to the contrary. In general, the direction of the causation between productivity and internationalization has been controversial (Greenaway and Kneller, 2007).

Studies that are more recent deal with the role of innovation in explaining the propensity for internationalization (Crisuolo *et al.*, 2005; Frenz and Ietto-Gillies, 2007). Castellani and Zanfei (2007) state that firms' proprietary assets are relevant

in determining the decision to enter foreign markets, and focus on the role international activities play in inducing firms to avail the opportunity to access foreign knowledge sources. They extend the number of variables capturing intra-industry heterogeneity and analyze how firms' international involvement is associated with differences in both productivity and firms' innovative behaviour. Benfratello and Razzolini (2008) consider, besides TFP, other variables connected to the firms' internationalization choices. Giovannetti *et al.* (2008) have analyzed the relationship between internationalization of firms and entrepreneurship heterogeneity. However, to the best of our knowledge, very few studies verify the interaction between the internationalization process and firms heterogeneity measured by a large diversity of characteristics, whether or not related to productivity advantages, like innovative behaviour, skills composition, investment decisions, organizational choices, ownership advantages, accumulation of technology and so on.

## *2.2 The internationalization process*

As we have stressed before, earlier literature points mainly to the categories of exporters and non-exporters. Only recently has FDI been added to the category of exports while a very limited number of studies bestow attention on non-equity forms of foreign market penetration. Basile *et al.* (2003) consider also commercial penetration operations that include foreign trade agreements, sales outlets abroad and so on and propose a ranked Foreign Expansion Index (FEI) that is measured in four categories: i) no-internationalization, ii) pure export, iii) export and commercial penetration operations, iv) export, commercial penetration operations, and FDI. Recently Castellani and Zanfei (2007) considered, besides export and FDI, the establishment of non-manufacturing activities abroad - a sort of intermediate category between exporters and the establishment of foreign manufacturing affiliates. Both papers use data from the Capitalia survey.

As far as the nature of the internationalization process is concerned, the adoption of the proximity-concentration trade-off paradigm leads to an internationalization process where firms tend to substitute FDI for exports when transport costs are larger and economies of scale are small. Moreover, various empirical studies state that only the most productive firms tend to engage in FDI as alternative to exports. As Basile *et al.* (2003) note, both international management theory and the theory of the firm are in agreement in treating the internationalization process as sequential, as it begins with occasional exports, next develops regular exports, to eventually reach FDI at the end of the sequence (Benito and Gripsrud, 1995). Following this point of view, the most efficient behaviour is to have fully owned production facilities abroad, whereas the intermediate form of foreign expansion is a second-best alternative to FDI. On the other hand, FDI can be considered complementary to export if FDI capital outflows create or expand the opportunity to export products. In such a case, FDI and exports can coexist in the same firm. The most recent literature models this alternative depending on the number of product lines the firm is assumed to produce: in a single-product setting, exports and FDI are substituted whereas complementarity

refers to multi-product firms, and exports and FDI become positively correlated if there are horizontal and vertical complementarities across product lines. In this framework, firms with more exporting experience and/or those more productive do not necessarily substitute FDI for exports and the foreign expansion process is cumulative. Basile *et al.* (2003) assuming that the international involvement increases from the category i) to category iv) test the hypothesis of the cumulative nature of the internationalization versus the substitutive one. A review on the so-called export platform FDI vs. complementarity can be found in Head and Ries (2004) and in Helpman (2006). The latter notes also that the traditional classification of FDI into vertical and horizontal forms has become less clear in practice, and Yeaple (2003) shows that firms adopt complex international integration strategies where horizontal and vertical FDI are complementary.

### 3. A STATISTICAL MODEL FOR INTERNATIONALIZATION CHOICES

Two different tools can be used to model the whole set of the internationalization choices. The first one is a multiple-choice model (ordered or unordered) where the set of alternatives consists of different internationalization modes and “no internationalization”: here the alternatives are exhaustive and mutually exclusive and the firm chooses only one of them, the one maximizing its profit function. The second is a multivariate model, where a binary choice (yes/no) corresponds to each internationalization category depending on some function of covariates specified through different equations and allowing the simultaneity of internationalization choices. As firm could adopt more than one mode of internationalization simultaneously, the main advantage of the second model is that we do not need to specify *a priori* all possible patterns of internationalization as it happens in the multiple-choice setting. In the latter case, the number of combinations increases very quickly with the number of internationalization modes, and becomes intractable when the number of modes exceeds three. Another advantage of the multivariate model is that we can use a different set of covariates driving the choice between the alternatives. Last, but not least, multiple-choice models impose restrictions on the structure of relationships among alternatives (i.e. correlations between disturbances). No such restriction is needed in the multivariate model. Relations among forms of internationalization are modelled through correlation parameters that have to be estimated. These correlations tell us how different internationalization modes combine and if there are unobserved factors, besides those explicitly considered, that simultaneously affect different choices of foreign expansion.

We adopted the MVP, specifying a joint multivariate normal distribution for the error terms. Formally considering  $M$  internationalization categories for each observation, there are  $M$  equations each describing a latent dependent variable to which there is a corresponding observed binary outcome (the observation subscript has been suppressed for notational convenience):

$$\begin{aligned}
y_m^* &= \beta'_m \mathbf{x}_m + \varepsilon_m \quad m = 1, \dots, M \\
y_m &= 1 \quad \text{if } y_m^* > 0 \text{ and } 0 \text{ otherwise}
\end{aligned} \tag{1}$$

where  $\mathbf{x}_m$  is a vector of  $p$  covariates for the  $m$ -th equation ( $m = 1, \dots, M$ ),  $\beta'_m$  is the corresponding vector of parameters, and  $\mathbf{\varepsilon} = [\varepsilon_m]_{m=1, \dots, M}$  is the error term vector distributed as multivariate normal, with a zero mean and variance-covariance matrix  $\mathbf{V}$ . The leading diagonal elements of  $\mathbf{V}$  are normalized to one and the off-diagonal elements are the correlations  $\rho_{mj} = \rho_{jm}$  for  $m, j = 1, \dots, M$  and  $m \neq j$ . If we assume that  $\varepsilon_m$  are distributed independently and identically with a univariate normal distribution, equation (1) defines  $M$  univariate probit models. The assumption of independence of the error terms means that information about the firm's choice on one internationalization mode does not affect the prediction of the choice probability of another internationalization mode for the same firm. If the unobserved correlations among outcomes are ignored, all the  $M$  equation in (1) could be estimated separately as univariate probit models. However, neglecting correlations leads to inefficient estimated coefficients, and could produce biased results in significance tests.

The probability of the observed outcomes for any observation is the joint cumulative distribution  $\Phi_M(\boldsymbol{\mu}; \boldsymbol{\Omega})$ , where  $\Phi_M(\cdot)$  is the  $M$ -variate standard normal cumulative distribution function with arguments  $\boldsymbol{\mu}$  and  $\boldsymbol{\Omega}$  that vary with observations; for each observation,  $\boldsymbol{\mu} = (\kappa_1 \beta'_1 \mathbf{x}_1, \kappa_2 \beta'_2 \mathbf{x}_2, \dots, \kappa_M \beta'_M \mathbf{x}_M)$  are upper integration points,  $\kappa_m$  are sign variables defined as  $\kappa_m = 2y_m - 1$ , being equal to 1 or  $-1$  depending on whether the observed binary outcomes equal 1 or 0, and  $m = 1, \dots, M$ . Matrix  $\boldsymbol{\Omega}$  has constituent elements  $\Omega_{mj}$ , where  $\Omega_{mm} = 1$  and  $\Omega_{mj} = \Omega_{jm} = \kappa_j \kappa_m \rho_{jm}$ .

Note that the MVP has a structure similar to that of a Seemingly Unrelated Regression model, except that in a MVP model the dependent variables are binary indicators.

Estimates of the equation's parameters and correlation terms are obtained by maximizing the log-likelihood function for a sample of  $n$  independent observations:

$$\ell = \sum_{i=1}^n \log \Phi_M(\boldsymbol{\mu}_i; \boldsymbol{\Omega}_i) \quad i = 1, \dots, n \tag{2}$$

This requires the evaluation of multivariate normal probabilities, i.e. the evaluation of  $M$ -dimensional integrals without a closed analytical form, for each observation and each iteration of the maximization process. The solution to this problem has been addressed through simulation methods that allow approximating higher dimension integrals appearing in the likelihood. The multivariate normal probabilities are calculated using the Geweke-Hajivassiliou-Keane (GHK) simula-

tor that results in unbiased estimates of the multivariate normal probabilities. Hajivassiliou and Ruud (1994) find that it is the most efficient among 12 different simulators.

The parameter estimates are obtained through the *Maximum Simulated Likelihood (MSL)* that consists of maximizing the *simulated log-likelihood* function:

$$\tilde{\ell} = \sum_{i=1}^n \log \tilde{\Phi}_M(\mu_i; \Omega_i) \quad (3)$$

where the individual terms are substituted, at each iteration of the maximization process for a given value of the parameters, by the simulated counterparts<sup>3</sup>.

The simulated log-likelihood function is not unbiased for log-likelihood even if the simulated probabilities are unbiased, because the logarithmic transformation is non-linear. However, simulation bias is reduced to negligible levels when  $R$  (the number of draws) rises with the sample size, thereby ensuring  $R/\sqrt{n}$  is sufficiently large (Hajivassiliou and Ruud, 1994). In practice, it has been observed that a relatively small number of draws may work well for ‘smooth’ likelihoods (Cappellari and Jenkins, 2003).

One important hypothesis to verify is that all cross-equation correlation coefficients are simultaneously equal to zero. This is carried out by means of a Wald test, and if the null hypothesis is not rejected, we can conclude that the choices of different internationalization modes are independent of each other; we could then equivalently fit  $M$  independent univariate probits for each internationalization form. On the contrary, if the null hypothesis is rejected, fitting  $M$  independent probits leads to unbiased but not efficient estimates. A correlation coefficient different from zero between a pair of choices, after controlling for firms characteristics, means that there are unobserved factors affecting both choices. This way we can explore the patterns of associations among internationalization forms and the complementary or substitute nature of their relationships.

#### 4. THE DATA

The data come from the 9th wave (covering the years 2001-2003) of the survey carried out every three years by Capitalia Observatory on Medium and Small firms.

The target population consists of Italian manufacturing firms with more than ten employees; firms with more than 500 employees are sampled in entirety whereas firms with less than 500 employees are selected on the basis of a stratified sample by size, activity sector (Pavitt classification), and geographical area (North, Centre, South). The final sample consists of 4289 firms.

<sup>3</sup> The model has been estimated using STATA (*StataCorp*, 2005) *ml* command, with a self-supplied code for the log-likelihood calculation, and the modules *mdraws* and *mvnp* developed by Cappellari and Jenkins (2006).



The survey collects detailed quantitative and qualitative information on property and businesses relationships, labour force, investments, innovation and R&D, internationalization, markets, and finance. This information is also linked to balance sheet data for the three years 2001–2003 covered by the survey, provided by the database AIDA (Bureau Van Dijk), available for 3450 firms.

One section of the questionnaire is devoted to internationalization choices, the basis for our analysis. The main forms of internationalization identified are:

- (a) export ( $y_1$ )
- (b) commercial penetration<sup>4</sup> ( $y_2$ );
- (c) trade or technical agreements with foreign firms ( $y_3$ );
- (d) FDI ( $y_4$ );
- (e) total or partial production offshoring ( $y_5$ );
- (f) outsourcing of services from abroad ( $y_6$ ).

These variables, considered as binary choices (yes/no), are the dependent variables of the six equations defining the multivariate probit.

Here, FDI refers to firms that engaged in foreign direct investments in the period 2001–2003, so it considers the FDI flows instead of the stock, as generally intended in the literature<sup>5</sup>. We decide to not discard this information in order to fully exploit the richness of the dataset, and at the same time we relied on the data concerning offshoring to capture the information about the stock of FDI.

The original sample size of 4289 was reduced due to various reasons. First, there was a problem of missing data for the dependent variables. Missing data for dependent variables were concentrated on large firms – having more than 500 employees – with a partial non-response rate in this class of approximately 75%. To limit the analysis to the remaining 25% could have lead to biased estimates, as this class would be under-represented in the whole sample. In order to reduce bias, we decide to deal with partial non-response imputing the whole vector of dependent variables using a hot-deck imputation in the classes defined by 2-digit Nace-based industry classification.

Secondly, there are missing values in covariates too. In particular, using a TFP measure as covariate implies conditioning only on observations with accounting data (3450 out of 4289). Moreover, data missing in the TFP index calculated in 2003 were because of missing data in accounting flows. Since imputation is more effective in reducing bias the more the covariate that drives the imputation is correlated with the outcome variables, we decided to impute missing data in the TFP index of 2003 with the corresponding measures of 2002, or of 2001 if the former were not available. To limit the effect of TFP outliers we adopted a winsorising process based on the 2.5th and 97.5th percentile (Chambers *et al.*, 2000). At the end of this cleaning procedure, a few missing data still remained in some other

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<sup>4</sup> Commercial penetration concerns operations like sales outlets, sales through local traders, sales arrangements with firms belonging to the group, and other promotional initiatives.

<sup>5</sup> Benfratello and Razzolini (2008) circumvented this problem by relying on other survey questions in order to define a proxy for horizontal FDI, using information about offshoring, the characteristics of the output produced abroad, the final destination of this output and the motivation for offshoring.

covariates so the final sample had 3103 firms. To evaluate the effect of missing data, we compared the distributions of the initial and the final sample by industry and size. Results (table 6 in Appendix) show that distributions are very close, except for the last size class where the non-response rate remained not negligible. Unfortunately, a comprehensive treatment of missing data would have added a considerable complexity to the model estimation that was beyond the scope of this paper, and is the object of further work.

Table 1 describes the marginal distribution of each internationalization category. The majority of the firms export and more than 30% of them carry out commercial penetration operations. The frequency of firms that take on offshoring is quite small and represents 7-8% of the total while the less chosen mode is foreign direct investments. The sampling distribution of patterns of internationalization is reported in table 2.

TABLE 1  
*Marginal distribution of internationalization modes*

<i>Modes</i>	<i>Freq.</i>	<i>Percent</i>
Export	2335	75.25
Commercial penetration	943	30.39
Agreements	631	20.34
FDI	116	3.74
Off-shoring	234	7.54
Service outsourcing	556	17.92

TABLE 2  
*Distribution of pattern of internationalization*

$(y_1, y_2, y_3, y_4, y_5, y_6)$	<i>Number</i>	<i>Freq.</i>	<i>Cum. percent</i>
(1 0 0 0 0)	987	31.81	31.81
(0 0 0 0 0)	690	22.24	54.04
(1 1 0 0 0)	331	10.67	64.71
(1 1 1 0 0)	228	7.35	72.06
(1 0 0 0 1)	158	5.09	77.15
(1 1 0 0 1)	118	3.8	80.95
(1 1 1 0 1)	104	3.35	84.31
(1 0 1 0 0)	99	3.19	87.5
(1 0 0 1 0)	52	1.68	89.17
(1 0 1 0 1)	52	1.68	90.85
Others	284	9.15	100
Total	3103	100	

Note:  $y_1$ =export,  $y_2$ =commercial penetration,  $y_3$ =agreements,  $y_4$ =FDI,  $y_5$ =off-shoring,  $y_6$ =services outsourcing

We noticed that the first ten combinations (ordered by frequency) accounted for 91% of all the firms. The 22% of the firms did not engage in any form of internationalization while 32% were only exporters. Firms exporting and carrying out commercial penetration constituted 11% of the firms and another 7% had also entered into trade and technical agreements with foreign firms. Other combinations of internationalization modes are less frequent but we noticed that all involve exporting. Under the category "Others" are combinations with a frequency smaller than 1% and altogether account for about the 9% of the firms.

## 5. ECONOMETRIC RESULTS

### 5.1. *The model specification*

The MVP was fitted to the six internationalization modes defined in the previous section. Binary dependent variables and equations ( $M = 6$ ) were defined for each of them as in (1).

We used the same set of covariates for each of the six equations, although MVP allows the use of different sets for each of them. In the literature, different covariates are proposed for different internationalization forms. However, non-equity internationalization forms are not considered nor the correlations among them and the more traditional ones. Therefore, with the aim of avoiding any *a priori* selection of the relevant covariates, we adopted here the same set of covariates for each equation of the MVP and we left to the hypothesis tests the task of detecting significant effects. Obviously, the analysis could lead to identification of different sets of significant covariates for each form.

Covariates are structural characteristics as well as variables describing the firm's behaviour regarding investments, innovation, inter-firm relationships, productivity and so on. In the following, we briefly discuss the choice of the covariates (for their exact definition see table 5 in Appendix).

Basic structural characteristics concern size, economic activity, and geographical location.

As for size, although it is generally believed that a firm should be large to compete in the global market, the sign of its relation with international involvement cannot be predicted *a priori* because the empirical evidence is mixed. While Barba-Navaretti *et al.* (2007) find a positive relation between the intensity of export and size, Sterlacchini (2001) finds a positive relation between export and size extending only until an upper limit above which the size of a firm does not increase its export propensity and he reports similar results found in other studies. When considering other internationalization forms, as in Basile *et al.* (2003), the effect of size is found to vary greatly with the degree of foreign expansion, being very small for firms engaging in export, commercial penetration, and FDI and even negative for firms engaging only in export. On the other hand, Benfratello and Razzolini (2008) find a significant and positive relation between size and the firms' international involvement. We used a five class-specification for categorizing the numbers of employees in the year 2003; these five classes are those used by Eurostat and Istat (the Italian Statistical Institute).

As for economic activity, we used the Pavitt classification in four broader categories,<sup>6</sup> instead of the Nace-based industry classification, in order to control for the sample design (the former is used as a stratification variable). Moreover, the

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<sup>6</sup> The Pavitt taxonomy is a classification of economic sectors based on technological opportunities, innovations, R&R intensity, and knowledge. It comprises four categories: *Supplier dominated* (producing traditional consumer goods), *Scale intensive* (which focuses on process innovation in order to exploit latent economies of scale), *Specialized suppliers* (which focuses on product innovation with strong R&D capabilities), and *Science based* (high commitment to R&D).

Pavitt classification is meaningful *per se* because it identifies sectoral patterns of technological change that are strongly industry-specific (Sterlacchini, 2001).

A specification with four classes for the geographical location of firms tries to capture the territorial differences of the structure of the local industrial systems. These differences are reinforced by the presence of industrial districts, not homogeneously distributed across the country, which can produce agglomeration economies that may give important competitive advantage to the small firms located there. Becchetti and Rossi (2000) and Intesa San Paolo (2007) found evidence of a positive effect of the firm's location in an industrial district on its export performance.

Drawing from literature, other characteristics that seem to affect internationalization choices are the age of the firm, the labour composition, and the ownership of the firm (foreign or domestic).

In general, the age of a firm can be considered a proxy for accumulated experience, and the perceived risk of investments in international markets; hence, age is expected to have a positive effect though some authors suggest that an opposite effect may result because older firms are not well acquainted with the increasingly global environment conditions that have arisen (Basile *et al.*, 2003).

Labour force composition (white collar upon total employment) is included because "internationalization usually requires more white collar activities like exporting and/or coordination of foreign and domestic plants or outlets" (Benfratello and Razzolini, 2008). Moreover, offshoring of low-skill production activities may change the composition of the labour force in favour of highly skilled workers (skill upgrading) resulting in a positive association between the share of white collar workers and the decision to offshore (for a survey on this issue see, among others, Lipsey, 2002). However, a negative sign may arise when the choice of offshoring or outsourcing originates from the lack of in-house specialized skills or equipment, so the lower the share of white collar the greater the propensity to outsource (Abraham and Taylor, 2006; Antonietti and Cainelli, 2007).

Firms controlled (to any extent) by foreign actors are likely to be part of international networks and are linked to other affiliates overseas; this facilitates commercial penetration of international markets as well as outsourcing of services or production activities (Girma and Görg, 2004; Cusmano *et al.*, 2006).

About inter-firm relationships, we considered two variables: group membership and membership in a consortium. Group membership might provide firms with the necessary marketing and financial resources to internationalize (Sterlacchini, 2001; Benfratello and Razzolini, 2008). We further split the group membership into three variables that identify the firm's position within the group (majority, intermediate, subsidiary). We expect subsidiary firms to be more involved in non-equity forms of internationalization and firms in a majority position to be involved in internationalization modes that need a more strategic view.

By joining a consortium partners are able to exploit economies of scale and scope that cannot be pursued by individual firms (Basile *et al.*, 2003).

The relationship between productivity and internationalization has been widely discussed in Section 2. Different measures of productivity have been used in lit-

erature depending on the amount of the available information. Here we used a Tornquist-type index number to measure the firm's TFP (Caves *et al.*, 1982; Good *et al.*, 1997). This approach, already used in the context of analysis of firms' internationalization by Delgado *et al.* (2002), Girma *et al.* (2005), Girma *et al.* (2007), has the advantage that it does not need to assume a specific functional form for the technology. Moreover, compared to alternative methods to measure TFP, the index number produces accurate and robust estimates (Van Biesebroeck, 2007). Data from balance sheets are used to calculate the TFP measure of 2003. The index was computed separately for each 2-digit Nace-based industry classification.

The literature has recently revealed the relationships between technological innovation, exports, and FDI (see Castellani and Zanfei, 2006, 2007). Such studies generally find that technological innovations improve exports and FDI. Basile *et al.* (2003) find that innovative activities have positive effects also on other internationalization modes (commercial penetration and trade and technical agreement). This could be explained by the paradigm that firms have to have some advantage to expand abroad; such advantage identified is technological accumulation. We measured innovative activity with different variables: a dummy for formal R&D expenditures in the period 2001-2003, two dummies for introduction of innovative products or processes, a dummy for innovation in organization due to product or process innovation, a dummy for investment in Information and Communication Technologies (ICT)<sup>7</sup>.

Finally, we also considered an indicator of capital intensity (the ratio capital/employment). As far as offshoring and outsourcing are concerned, a negative association with capital intensity implies that firms are more willing to outsource labour-intensive activities (Antonietti and Cainelli, 2007).

## 5.2. Marginal effects from model estimates

The estimated MVP (table 7 in Appendix) was tested for various hypotheses. Distinct Wald tests for the hypothesis that all the coefficients in each equation are jointly equal to zero reject the null and also the hypothesis that the vectors of coefficients are equal across the six equations is rejected. Wald tests for the significance of single parameters in each of the six equations point out that coefficients are significantly different from zero for some internationalization modes but not for all of them. Because values of coefficients does not reveal any information about the magnitude of the effects of covariates on probabilities of success, either marginal or joint, except for determining the signs of effects, we preferred to follow the standard practice in literature and summarize results in terms of marginal effects on success probability for each dependent variable (i.e. marginals).

Each marginal effect (table 3) represents the change in probability of success given a one-unit change in the associated regressor (a change from zero to one

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<sup>7</sup> The survey collects data on the amount of R&D expenditures and investment in ICT, but we did not use them because of a large number of missing data.

for binary variables). For the  $m$ -th equation and the  $k$ -th continuous covariate, the marginal effect is calculated using  $\partial E(y_m | x_{mk}) / \partial x_{mk} = \phi(\hat{\beta}'_m x_m) \hat{\beta}_{mk}$  at mean values for the covariates (Greene, 2003). For the  $k$ -th binary variable, it is the difference  $\hat{P}(y_m = 1 | x_{mk} = 1) - \hat{P}(y_m = 1 | x_{mk} = 0)$  calculated holding all the other covariates constant at mean values. Here  $\hat{\beta}_{mk}$  is the coefficient estimate of the covariate  $x_{mk}$  from the mode-type  $m$  equation, and  $\phi(\cdot)$  is the probability density function of a standard normal distribution with zero mean and unit variance. Because marginal effects are a non-linear combination of model parameters, standard errors (not reported) were estimated by the Delta method and significance was tested by a Wald test. More detailed results are available from the authors upon request.

### *Age*

The age of the firm is not significantly associated with any internationalization mode. It seems that, as pointed out by some authors, if some positive effect of age exists it may be offset by the fact that the older firms are not well acquainted with increasingly global environment conditions.

### *Labour composition*

Labour composition is significantly and positively associated with all the internationalization modes but FDI. The larger effect is found in the probability of engaging in commercial penetration, about 22 percentage points.

### *Size*

The relationship between size of the firm and each of the internationalization modes is shaped more or less like an inverted U, so the probability for each internationalization mode grows until an upper limit is reached and then declines (the reference class is 11-20 employees). The coefficient for very large firms (more than 500 employees) is never significant except when considering service outsourcing. A possible explanation is that besides some size threshold, other factors became more important for the choice to internationalize. This finding is in accord with that obtained by Sterlacchini (2001) for exporting firms.

### *Industry*

There is a strong significant association of the Pavitt sector only with exports, commercial penetration, and offshoring. Specialized suppliers are those that export most and carry out commercial penetration, even more than firms in the supplier-dominated sector (which comprises "traditional" sectors) that, on the contrary, choose more frequently than others to offshore. It may be argued that firms in the traditional sectors in their attempts to reduce production costs resort to offshoring. Scale-intensive firms are the ones that less likely engage in any form of internationalization.

### Geographical location

We find that firms located in the south of Italy, more than others, venture commercial penetration and conclude agreements with foreign firms. No significant associations are found with other internationalization forms<sup>8</sup>.

### Location in industrial districts

Results confirm previous findings that firms located in industrial districts export more than others do (plus 10 points), but we do not find significant associations with other internationalization modes.

TABLE 3  
*Estimated marginal effects on marginal probabilities*

<i>Variable</i>	<i>Export</i>	<i>Comm. penetration</i>	<i>Agreements</i>	<i>FDI</i>	<i>Off-shoring</i>	<i>Services outs.</i>
<i>Pred. Probabiy</i>	0.800***	0.272***	0.157***	0.019***	0.046***	0.132***
<i>Lnet</i>	0.011	-0.025	-0.015	0.003	-0.007	-0.011
<i>Labcomp</i>	0.097*	0.217***	0.114**	0.008	0.070***	0.095**
<i>Distr</i>	0.048**	-0.001	-0.003	0.001	-0.003	-0.008
<i>Foreign</i>	0.039	-0.102***	-0.013	-0.001	0.001	0.124***
<i>Magg</i>	-0.006	0.04	0.103**	0.048**	0.060**	0.045
<i>Subsid</i>	-0.04	-0.073**	-0.013	-0.007	-0.01	0.015
<i>Interm</i>	0.046	0.022	0.02	0.047**	0.070**	0.074*
<i>Conсор</i>	0.028	0.084**	0.029	-0.002	0	0.026
<i>Capint</i>	-0.119***	-0.075*	-0.102**	-0.013	-0.093***	-0.022
<i>Ict</i>	0.02	0.070***	0.037*	0.012*	0.022**	0.039*
<i>Innopro</i>	0.048***	0.055***	0.022*	0.002	0.003	0.011
<i>Innoprc</i>	-0.007	-0.002	0.038*	-0.008	-0.001	0.015
<i>Innoorg</i>	-0.016	0.049*	0.036*	0.005	-0.002	0.005
<i>R&amp;D</i>	0.134***	0.187***	0.105***	0.017**	0.015	0.073***
<i>Tfp</i>	0.062***	0.032*	0	0.005	0.011	0.023*
<i>Size (Ref: 11-20 Employees)</i>						
21-50	0.049*	0.048	0.048*	0.013*	-0.005	0.044*
51-250	0.082*	0.088**	0.068*	0.019*	0.031*	0.083***
251-500	0.085	0.174**	0.1	0.015	0.068	0.08
>500	0.064	0.067	0.093	0.033	0.067	0.153*
<i>Geographical Area (Ref: South And Islands)</i>						
North-West	0.02	-0.129***	-0.106***	0.003	-0.008	0.007
North-East	0.006	-0.108***	-0.093**	0.003	0.006	0.021
Centre	-0.007	-0.067*	-0.073*	0.013	0.023	0.022
<i>Sector (Ref: Supplier Dominated)</i>						
Scale Intens.	-0.116***	-0.067**	-0.03	-0.014**	-0.053***	-0.060***
Spec. Suppl.	0.093***	0.073***	0.029	-0.002	-0.028**	0.002
Scien. Based	-0.130**	-0.014	-0.035	-0.008	-0.055***	-0.032

Note: \* p<0.05; \*\* p<0.01; \*\*\* p<0.001

### Inter-firm relationships

To be a member of a group is associated with the internationalization process and this relationship depends on the firm's position in the group. Firms that have a majority position have a greater probability than others of concluding agreements and engaging in FDI and offshoring (plus 10, 5, and 6 points respectively). Firms in the intermediate position too have a greater probability not only to execute FDI and offshoring ventures (plus 5 and 7 points) but also to outsource services abroad. This evidence is easily explained by the fact that the controlling

<sup>8</sup> In a previous estimation exercise not reported here, with no industrial district indicator and a dummy for investments in fixed capital instead of capital intensity, we found a strong positive association between location in the North of Italy and exports.

firms, as well as intermediate firms, may invest in or let other firms of the group produce for them. On the contrary, subsidiary firms less likely adopt commercial penetration than others (minus 7 points).

Belonging to a consortium also facilitates commercial penetration of foreign markets; in fact, the probability of members engaging in this internationalization mode is higher by 8 points than non-members.

#### *Foreign control*

Foreign-owned firms, even those partially owned, have a smaller probability of engaging in commercial penetration by 10 points while the probability of outsourcing services from abroad is higher by 12 points. Here the reverse of the explanation used for group membership may be applied, if foreign-owned firms are members of economic groups in intermediate or subsidiary positions.

#### *Capital intensity*

As expected, a strong negative association is found with offshoring (minus 9 points), implying that firms are willing to relocate especially labour-intensive activities. However, a significant negative association is found also with exports (minus 12 points), commercial penetration (minus 7 points), and agreements (minus 10 points) implying that firms involved in higher capital-intensive activities are less interested in international commitment.

#### *Innovative activity*

As expected, innovative activity has a strong and positive association with internationalization. The probability of exporting is greater for firms investing in research and development (plus 13 points) and producing innovative products (plus 5 points). Effects on the probability of engaging in commercial penetration are even more valuable: plus 19 points for firms investing in R&D, plus 5 point for firms producing innovative products and introducing innovations in organization, plus 7 point for firms investing in ICT. The probability of concluding agreements with foreign firms is larger for firms investing in R&D (plus 10 points), innovating products, processes, and organization (ranging from 2 to 4 points), and investing in ICT (plus 4 points). Firms investing in R&D and in ICT also have a greater probability of engaging in FDI and outsourcing of services. On the contrary, the only significant association with offshoring was found to be the investments in ICT. This may suggest, as already pointed out in the case of firms in the traditional sectors that offshoring is equally carried out by firms whose core activity is not producing innovative products in order to improve their competitiveness by reducing production costs in low-wage countries.

#### *Productivity*

A significant and positive association between productivity and internationalization was found for some but not all the modes. One unit change in TFP index corresponds to a greater probability of exporting by 6 points, a greater probability of engaging in commercial penetration by 3 points, and a greater probability of



outsourcing services from abroad by more than two points. No statistically significant effect was found on agreements, FDI or offshoring<sup>9</sup>. This last result seems surprising in view of the recent empirical evidence that finds significant productivity differentials between domestic firms, exporters and multinational firms. We have to stress, however, that we evaluated the association between TFP and the marginal probability for a firm to engage in one of these internationalization forms, contrasted with firms that do not internationalize but also with firms that internationalize in different ways.

### 5.3. Association patterns

The other point that deserves attention is the analysis of the correlation coefficients (table 4)<sup>10</sup>. In this context, a correlation coefficient different from zero between a pair of choices means that there are unobservable factors affecting both choices and reveals the pattern of association, after controlling for firm's characteristics. As we can see, all correlation coefficients are significantly different from zero. A Wald test rejects the null that correlation coefficients are jointly equal to zero (internationalization choices are independent of each other). All correlations are positive implying that, after controlling for observable characteristics, it is more likely a firm adopts more than one internationalization mode.

Some correlations in particular are notable, with values greater than 0.5. Correlation between FDI and offshoring is quite valuable (0.76) so we expect that firms which invest abroad are more likely offshoring part of their production, all other characteristics being equal. It does not seem hazardous to claim that direct investments in foreign countries are made mainly, but not exclusively, with the aim of creating production facilities abroad and transferring production activities. However, FDI may coexist to some extent also with exports and agreements (estimated correlations of 0.37), evidencing that firms do not merely substitute FDI for export. As expected, offshoring shows small correlation values with all other modes, apart from FDI.

This fact calls for the substitute relationship between offshoring and others internationalization forms, as already stressed by some authors who have analysed the relationship with exports (Helpman *et al.*, 2004; Basevi and Ottaviano, 2001). The decision to offshore is driven mainly by the aim to reduce production costs exploiting labour (and other input) cost differentials across countries. This finding is also consistent with the analysis of the motivations behind offshoring collected by the survey and with the previous evidence that offshoring is practised especially by firms in traditional sectors and by those that do not carry out innovative activities.

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<sup>9</sup> When capital intensity is not considered, we find a significant positive association between TFP and offshoring.

<sup>10</sup> SML estimates the elements of the Cholesky factorization matrix  $\mathbf{C}$  of the variance-covariance matrix  $\mathbf{V}$ ; correlation coefficients are non linear combinations of the elements of  $\mathbf{C}$  based on the relation  $\mathbf{V}=\mathbf{C}\mathbf{C}'$ ; standard errors are estimated by the Delta method.

TABLE 4  
Correlation estimates

Parameter	Coef.	Std. Err.	Z	P> $\chi$	[95% Conf. Interval]	
$\rho_{21}$	0.686	0.031	22.180	0.000	0.625	0.746
$\rho_{31}$	0.443	0.040	10.950	0.000	0.363	0.522
$\rho_{32}$	0.550	0.027	20.400	0.000	0.497	0.603
$\rho_{41}$	0.373	0.088	4.240	0.000	0.201	0.545
$\rho_{42}$	0.352	0.053	6.630	0.000	0.248	0.456
$\rho_{43}$	0.373	0.054	6.970	0.000	0.268	0.478
$\rho_{51}$	0.221	0.063	3.530	0.000	0.098	0.344
$\rho_{52}$	0.111	0.047	2.360	0.018	0.019	0.204
$\rho_{53}$	0.254	0.047	5.420	0.000	0.162	0.346
$\rho_{54}$	0.765	0.035	21.940	0.000	0.697	0.833
$\rho_{61}$	0.335	0.044	7.540	0.000	0.248	0.422
$\rho_{62}$	0.274	0.035	7.890	0.000	0.206	0.342
$\rho_{63}$	0.335	0.035	9.680	0.000	0.267	0.403
$\rho_{64}$	0.153	0.060	2.570	0.010	0.036	0.270
$\rho_{65}$	0.130	0.050	2.630	0.008	0.033	0.227

Wald test:  $\rho_{21} = \rho_{31} = \dots = \rho_{65} = 0$   $\chi(15) = 1589.71$   $p\text{-value} = 0.000$   
 Note: The indexes refer to the equations: 1=export, 2=commercial penetration, 3=agreements, 4=FDI, 5=off-shoring, 6=services outsourcing; standard errors are estimated by the Delta method; \*p<0.05; \*\*p<0.01; \*\*\*p<0.001

A high correlation exists instead between exports and commercial penetration (0.68), implying that the two modes are complementary or subsidiary strategies. Export is associated to some extent also with trade and technical agreements (0.44), as the latter may specifically concern exports. Moreover, a significant association was found between commercial penetration and agreements, with a correlation of about 0.55. This is not surprising because agreements may concern commercial penetration operations through local traders, sales arrangements with firms belonging to the group, and other promotional initiatives. In conclusion, among exports, commercial penetration, and agreements there are subsidiary and complementary relationships that exploit synergies to expand abroad.

All the other values are below 0.35. In particular, services outsourcing is weakly associated with others internationalization modes, especially with FDI and off-shoring and only slightly higher with exports and agreements; we can conclude, then, that the decision to outsource services is essentially related to considerations other than those driving internationalization strategies.

## 6. SOME CONCLUDING REMARKS

In this paper, we explored firms' internationalization choices and their associations with heterogeneity of firms measured by various dimensions. Besides the traditional exports and FDI considered in the previous literature, we considered non-equity forms of international involvement. In order to evaluate this large array of internationalization modes in a multivariate framework, we fitted a MVP that allowed us to avoid any *a priori* assumptions, such as the substitutive or cumulative ones, on internationalization patterns.

Results obtained in this study can be summarized along two main directions.

Firstly, the consideration of non-equity internationalization forms, besides the

more traditional exports and FDI, allows a detailed description of the firms' behaviour in expanding abroad. From the analysis of the correlation coefficients, it arose that Italian firms, together with exports and/or FDI, adopt various non-equity internationalization forms. We found that, even conditionally on characteristics of firms, there are subsidiary/complementary relationships existing among the forms of internationalization. In particular, firms try to exploit synergies in exporting, engaging in commercial penetration and making agreements with foreign firms. On the other hand, offshoring seems mainly aimed at reducing production costs and exploiting labour cost differentials rather than as part of a wider strategy of internationalization, principally, through direct investments in foreign countries. However, FDI may coexist to some extent also with exports and trade and technical agreements. This multifaceted picture of the firms' internationalization patterns could be a stimulus to extend the model of heterogeneous firms (Melitz, 2003; Helpman *et al.*, 2004) to more than two forms of firms' international involvement.

Secondly, the empirical evidence presented in this study confirms the idea, present in the most recent literature on firms' internationalization (Castellani and Zanfei, 2007; Frenz and Ietto-Gillies, 2007), that firms' heterogeneity needs to be described by means of a multiplicity of firms' characteristics in addition to TFP. Besides differences among industries and regions across the country, the findings reveal that inter-firm relationships, skill composition, innovative activities, and proprietary assets all play a role in differentiating the patterns of internationalization. In particular, labour organization and especially innovative activity are strongly associated with international involvement in the same way as productivity is.

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## APPENDIX

TABLE 5  
*Variables definition*

Variable	Description
<b>Dependent variables</b>	
Export	1 if the firms exported in 2003
Comm. penetration	1 if the firm performed commercial penetration abroad during 2001-03
Agreements	1 if the firm concluded commercial or technical agreement with foreign firms in 2001-03
FDI	1 if the firm performed FDI during 2001-03
Off-shoring	1 if the firm produces part or the whole output in a foreign country
Services Outsourcing	1 if the firm acquires services from abroad
<b>Covariates</b>	
<i>Size: five dummies for the numbers of employee in 2003</i>	
11-20 emp.	11-20 employees
21-50 emp.	21-50 employees
51-250 emp.	51-250 employees
251-500 emp.	251-500 employees
>500 emp.	More than 500 employees
<i>Sector: four dummies for the Pavitt sector</i>	
Supplier dominated	Textiles, footwear, food and beverage, paper and printing, wood
Scale intensive	Basic metals, motor vehicles and trailers
Specialized supplier	Machinery and equipment, office accounting and computer machinery, medical optical and precision instruments
Science based	Chemicals, pharmaceuticals, electronics
<i>Geographic area: four dummies for location:</i>	
North-West	Liguria, Lombardia, Piemonte, Valle d'Aosta
North-East	Emilia-Romagna, Friuli Venezia-Giulia, Trentino Alto-Adige, Veneto
Centre	Abruzzo, Lazio, Marche, Molise, Toscana, Umbria
South and Islands	Basilicata, Calabria, Campania, Puglia, Sardegna, Sicilia
Lneta	Log of 2004 minus the establishment year
Labcomp	White collars and managers over total employment in 2003
Distr	1 if the firms is located in an industrial district
Foreign	1 if any foreign actor owns and controls the firm
Magg	1 if the firms is a member of a group in a majority position
Interm	1 if the firms is a member of a group in an intermediary position
Subsid	1 if the firms is a member of a group in a subsidiary position
Conсор	1 if the firm belongs to a consortium
Capint	Ratio of stock of fixed capital on employment in 2003
Innopro	1 if the firm introduced product innovations in 2001-03.
Innoprc	1 if the firm introduced process innovations in 2001-03.
Innoorg	1 if the firm innovated organization as a consequences of product or process innovation in 2001-03
R&D	1 if the firm had R&D expenditure during 2001-03
Ict	1 if the firm invested in hardware, software and telecommunications in 2001-03
Tfp	Total Factor Productivity index in 2003

TABLE 6  
*Distribution by industry and size, initial and final sample*

<i>Industry</i>	<i>Initial sample</i>		<i>Final sample</i>	
	<i>Freq.</i>	<i>Percent</i>	<i>Freq.</i>	<i>Percent</i>
Food and beverages	484	11.29	358	11.54
Textiles	331	7.72	255	8.22
Clothing	141	3.29	110	3.54
Leather	174	4.06	125	4.03
Wood	112	2.61	85	2.74
Paper products	113	2.64	86	2.77
Printing and publishing	107	2.5	81	2.61
Coke, refined petroleum products and nuclear fuel	29	0.68	24	0.77
Chemicals	238	5.55	171	5.51
Rubber and plastics	224	5.23	169	5.45
Non-metal minerals	262	6.11	181	5.83
Metals	165	3.85	104	3.35
Metal products	545	12.71	402	12.96
Nonelectric machinery	614	14.32	430	13.86
Office equipment and computers	12	0.28	7	0.23
Electric machinery	170	3.97	113	3.64
Electronic material and communication	83	1.94	59	1.9
Medical apparels and instruments	82	1.91	60	1.93
Vehicles	74	1.73	47	1.51
Other transportation	44	1.03	25	0.81
Furniture	276	6.44	211	6.8
Missing	7	0.16		
<b>Total</b>	<b>4 287</b>	<b>100</b>	<b>3 103</b>	<b>100</b>
<i>Size</i>				
11-20 employees	948	22.11	671	21.62
21-50 employees	1 267	29.55	973	31.36
51-250 employees	1 584	36.95	1 214	39.12
251-500 employees	226	5.27	144	4.64
>500 employees	262	6.11	101	3.25
<b>Total</b>	<b>4 287</b>	<b>100</b>	<b>3 103</b>	<b>100</b>

TABLE 7  
*Multivariate probit estimates – SML using GHK simulator with R=300 replications*

Variable	Export		Commercial penetration		Agreements		FDI		Off-shoring		Service Outsourcing	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Lneta	0.04	0.045	-0.075	0.041	-0.063	0.043	0.057	0.075	-0.068	0.059	-0.052	0.045
Labcomp	0.347*	0.155	0.653***	0.150	0.473**	0.158	0.185	0.278	0.724***	0.209	0.444**	0.164
Distr	0.172**	0.059	-0.004	0.054	-0.013	0.058	0.027	0.094	-0.028	0.078	-0.039	0.060
Foreign	0.146	0.147	-0.343**	0.115	-0.052	0.117	-0.027	0.181	0.006	0.145	0.443***	0.110
Magg	-0.023	0.124	0.117	0.098	0.345***	0.099	0.614***	0.135	0.454***	0.119	0.179	0.103
Subsid	-0.139	0.080	-0.232**	0.076	-0.05	0.079	-0.172	0.150	-0.115	0.113	0.063	0.081
Intern	0.175	0.142	0.065	0.105	0.074	0.110	0.596***	0.148	0.506***	0.129	0.279**	0.108
Consort	0.102	0.082	0.240**	0.074	0.108	0.079	-0.052	0.140	-0.001	0.122	0.107	0.083
Capint	-0.425***	0.103	-0.227*	0.110	-0.424***	0.125	-0.297	0.245	-0.959***	0.224	-0.104	0.123
Ict	0.072	0.059	0.218***	0.061	0.145*	0.066	0.292*	0.132	0.250**	0.096	0.170*	0.070
Innoproc	0.324***	0.064	0.275***	0.057	0.137*	0.061	0.06	0.104	0.058	0.085	0.078	0.064
Innoprc	-0.024	0.062	-0.005	0.057	0.142*	0.060	-0.171	0.102	-0.021	0.084	0.064	0.063
Innoorg	-0.058	0.066	0.147*	0.058	0.133*	0.061	0.1	0.100	-0.021	0.083	0.023	0.063
R&D	0.489***	0.065	0.563***	0.060	0.394***	0.064	0.358**	0.117	0.149	0.090	0.307***	0.067
Tfp	0.221***	0.045	0.096*	0.042	-0.002	0.044	0.1	0.079	0.117	0.062	0.110*	0.046
21-50 empl.	0.161*	0.077	0.155	0.083	0.201*	0.089	0.412	0.224	-0.066	0.139	0.221*	0.100
51-250 empl.	0.283**	0.109	0.274*	0.108	0.273*	0.115	0.523*	0.257	0.317	0.167	0.378**	0.124
251-500 empl.	0.296	0.212	0.508**	0.184	0.382*	0.193	0.449	0.351	0.559*	0.253	0.366	0.198
>500 empl.	0.216	0.276	0.212	0.225	0.359	0.237	0.713	0.414	0.551	0.311	0.620**	0.239
North-West	0.073	0.087	-0.375***	0.088	-0.374***	0.092	0.081	0.183	-0.095	0.140	0.029	0.100
North-East	0.02	0.089	-0.308***	0.089	-0.322***	0.093	0.082	0.185	0.057	0.138	0.092	0.102
Centre	-0.023	0.091	-0.184*	0.093	-0.245*	0.098	0.26	0.189	0.211	0.142	0.095	0.107
Scale Intensive	-0.358***	0.071	-0.219**	0.077	-0.119	0.080	-0.391*	0.163	-0.653***	0.138	-0.282**	0.087
Specialized Supplier	0.388***	0.075	0.209***	0.062	0.105	0.066	-0.032	0.109	-0.258**	0.091	0.009	0.069
Science Based	-0.396**	0.138	-0.043	0.132	-0.143	0.140	-0.19	0.228	-0.715**	0.217	-0.139	0.144
Constant	0.027	0.180	-1.018***	0.175	-1.168***	0.185	-3.053***	0.381	-1.717***	0.265	-1.624***	0.196

*Obs* = 3103      *Logl* = -6387.98      *Df* = 171  
Legend: \*p<0.05; \*\*p<0.01; \*\*\*p<0.001

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SUMMARY

*A multivariate framework to explore firms' internationalization patterns: the role of individual heterogeneity*

In this paper, we explore the internationalization pattern of firms and its relationship with firms' heterogeneity. Besides the more traditional exports and Foreign Direct Investments (FDI), we consider various forms of non-equity internationalization. The use of a Multivariate Probit Model allows us to assess the associations among the choices driving the firms' internationalization strategy as a whole and, at the same time, to avoid *a priori* assumptions on the internationalization patterns. From the empirical evidence, two main results emerge. At first, we observe that Italian firms jointly adopt various internationalization forms, others than exports and FDI, conditionally to characteristics of the firms. The hypothesis reported in literature of a complementary or subsidiary relationship between exports and FDI is then confirmed also for non-equity internationalization forms. Secondly, we find that the heterogeneity of firms, measured by a large range of variables, has an important role in defining the choice of firms on the patterns of internationalization. Thus in this context, we endorse the emerging opinion asserting that various dimensions other than productivity are relevant.