Export and Product Innovation at Firm Level*

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Abstract

Past research showed that exporters perform better than non-exporters in several dimensions, among which innovation activies. However, while the positive impact of innovation on export is widely accepted, research on the innovation-enhancing effect of export is scant. In this paper, we analyze the relationship between product innovation and export by using a rich firm-level survey on Italian manufacturing. In particular, we seek to identify the causal effect of export status on the introduction of product innovations (*learning by exporting*). Preliminary evidence shows large and positive average causal effects of a firm's export status on the probability of innovating its products.

Keywords. Export, Firms, Product Innovation, Italy, Manufacturing
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1 Introduction

Innovation, and in particular production of new goods, is widely recognized as a primary source of economic growth by the economic literature. In the same way, the emphasis on the 'virtues' of the globalization process has been growing in the last years. In spite of this, the interactions between the two phenomena and the channels through which they develop are far from being clear, especially when the attention is focused on individual firm's behaviour, instead of countries or industries.

The causal pathways between innovation[1] and internationalization may be bidirectional.

The impact of trade on innovation acitivities has been widely analysed by the endogenous growth and the new trade theory literatures. In this framework the effect of international knowledge spillovers (through flows of ideas and/or goods) and the effect of trade on the incentive to invest in R&D and by this channel on innovation (Grossman and Helpman, 1991; Aghion and Howitt, 1998) have been emphasised, drawing in that way a distinction between those effects that could be called 'pure spillovers' and those mediated by market incentives.

Despite the importance that these literatures have given to the role of firm's behaviour with respect to the innovation process, analysis is often carried out only at a macro level. That is to say, the unit of analysis is the representative firm. Firms are assumed accordingly to be homogeneous in their characteristics and consequently in their behaviours (i.e. all the firms react in the same way to the same incentives: all firms export and invest in R&D and are subject to spillovers or learning processes). Athough this literature makes an attempt to shed light on the black box of technological progress, it does not help to explain heterogeneity in firm behaviour. That is to say, it analyzes the relationship between trade and innovation at the macro-industry level, without shedding light on the effect that the individual firm's export activity may, or may not, have on its individual innovation behaviour, and on the pathways through which this effect takes place.

The other direction of causality (i.e. from innovation towards trade) has also been at the core of many contributions in the tradition of the endogenous growth and the new trade literatures, in particular with those contributions studying dynamic comparative advantages and imitation (Krugman, 1979; Grossman and Helpman, 1991). Again, the analyses are carried out mainly at a macro-industry level. It is only recently that the trade literature has been turning its attention to the firm, identifying in firm's heterogeneous characteristics and the role of sunk costs of exporting the primary determinants of internationalization activities. This literature points to the

[1] In its different modes, e.g. introduction of new goods and/or higher quality goods, introduction of new methods of production and/or new organizational modes, the use of new materials and /or inputs.

self-selection as the key mechanism through which firms that are more efficient (or more innovative) enter foreign markets because they are productive (and perhaps innovative) enough to bear the sunk costs of entry (Hallak and Sivadasan, 2007; Verhoogen, 2008). Although this literature focuses on firm heterogeneity, in that way looking in more depth at firm's behaviour, the emphasised direction of causality is from the ex-ante exogenous ability endowment to export activity: firms that are ex-ante already better than others (e.g., larger firms, with a higher propensity to invest in R&D, more efficient, more innovative) self-select into foreign markets. Despite looking at individual firms and focusing on their different characteristics, this literature does not explore whether and how export might affect in turn the 'ability' of a firm. That is to say, it is not generally analysed how firm's 'ability' (i.e. productivity or innovativity) may be enhanced by learning effects running through export.

The empirical evidence assessing the presence of spillover effects from international trade has also been conducted mainly, even if not exclusively, at a macro level (for a systematic review of the empirical evidence, see Keller, 2004; Breschi et al., 2005). Despite quite recently a new strand of firm-level empirical analyses has focused on the relationship between export and productivity (Wagner, 2007), and several recent contributions have shown that a firm's self-selection mechanism is present by using proxies of innovation, the research on learning effects of export on product innovation is very scant.

Finally, it has to be mentioned that research on firm level learning effects of internationalization processes has been traditionally centered both theoretically and empirically on Foreign Direct Investment (FDI) and the activities of Multinational firms.

In light of the fact that export is still the most prevalent internationalization mode among firms, the aim of the current paper is to answer the question whether exporting does positively affect a firm's innovation performance, with particular attention to product innovation. Investigating this direction of causality means that we will be mainly interested in assessing potential positive effects of trade on a measure of firm's performance different from productivity, which has been already widely investigated, namely its ability to introduce product innovations. Despite both directions of causality between export and innovation are relevant, our analysis aims to clarify whether and why the most common internationalization mode (exporting) could affect innovation, inducing a virtuous circle, that would open room for policy interventions in the direction of export promotion. At the same time it helps to shed light on one potential determinant of firm's product innovation.

We study the effect of export on product innovation using a rich firm-level survey on Italian manufacturing firms which gathers a wealth of information on both the inputs and the outputs of firms' innovative and internationalization activities.[2] The empirical strategy adopted (i.e. instrumental variables) enables us to take into account the potential endogeneity of export activities with respect to the production of innovation at the firm-level and to address, therefore, the *self-selection* issue which has been recently emphasised both by the theoretical and the empirical literature of the New New Trade Theory.

Our preliminary analysis shows two interesting results.

First, we find a significant and large positive causal effect of export on product innovation, which is consistent with *learning by exporting* effects on firm innovation. It is worth noting that a causal effect from firm's performance (e.g., ex ante productivity or innovation) towards export implies that policies promoting international trade would have a positive effect on an industry's and maybe a country's aggregate performance, through firms' selection and survival only of the better performing firms, but not on the performance of *existing* firms. Finding a positive effect of a firm's involvement in foreign markets on its competitiveness has much stronger policy implications. It would mean that policies promoting trade liberalization could also have an indirect positive effect on the competitiveness of firms that already operate in the market. Second, our analysis points to foreign knowledge spillovers as a relevant pathway through which the effect of export materializes. Finding a positive effect of trade on firm's competitiveness operating through learning instead of R&D expenditures means that policies promoting trade liberalization have a indirect effect on firm's competitiveness which works independently of formal R&D. This is extremely important in particular for countries that structurally underinvest in R&D and where the structure of production is mainly dominated by small-medium firms, family ownership and a less developed financial market, which act as obstacles to R&D investments.

The structure of the paper is as follows. Section 2 includes a brief survey of the literature on the potential two-way causal link between export and innovation. Section 3 describes the empirical strategy and Section 4 the data used. Sections 5 reports our main results while in Section 6 we discuss the implications of our analysis. Section 7 concludes.

2 Motivation and previous literature

In the following subsections we report an overview of some relevant literature.

[2]For some related literature using the same data set see Basile (2001), Parisi et al. (2006) and Benfratello and Razzolini (2007), among others.

2.1 The relationship between trade and innovation

As mentioned in the introduction the relationship between trade and innovation is most likely to be bidirectional.

The role of internationalization in enhancing innovation has been widely emphasized by the endogenous growth and the new trade theory literatures, where a distinction can be made between the effect of international knowledge spillovers generated either by international flow of ideas (Grossman and Helpman, 1991; Rivera-Batiz and Romer, 1991) or by the international flows of goods (Rivera-Batiz and Romer, 1991; Coe and Helpman, 1995; Eaton and Kortum, 2002) and the effect of trade on the incentive to invest in R&D and through this channel on innovation (Aghion and Howitt, 1998). The 'international flow of ideas' represents the flow of information and knowledge which goes through personal contacts that develop by means of commercial interaction, that is through interactions with foreign agents (buyers, suppliers, intermediaries). On the one hand, exporters may need technical assistance from foreign buyers and through this channel directly access the knowledge of foreign suppliers, technicians or other researchers. On the other hand, foreign consumers may have different tastes and, in any case, the increase of the market size implies an increase in the variety of consumers' needs. Alternatively, if the buyer is a foreign firm using different and more advanced technologies, it may require high quality-advanced technology goods to be used in its production process. In the 'international flow of ideas' view, the productivity of innovative activity increases with the stock of innovations (past knowledge), and so it increases with free access to foreign innovations, but this channel is at work only with direct commercial exchange with foreign agents.

The 'international flows of goods' channel implies that knowledge spillovers are generated only through the use of an intermediate or a capital good by the domestic firm.

Access to international markets could have two different effects with respect to the incentives to invest in R&D. According to the basic Schumpeterian hypothesis, the increase in the size of the market with the associated increase in the monopolistic rent for successful innovators, will provide incentives to increase firm's R&D expenditures. On the other side, according to the recent extensions of the Schumpeterian model (see Aghion and Howitt, 1998; Aghion et al., 2005), the increase in the product market competitive pressure might force firms to innovate in order to survive.

It is worth noting that while the theoretical literature can clearly distinguish between pure knowledge spillovers and transfer of knowledge through market transactions, empirically this distinction is far from being clear (Breschi et al., 2005). Keller (2004), in a systematic review of the empirical literature on the international knowledge spillovers, underlines the role of trade and other internationalization modes in the diffusion of 'noncodified' technology. According to this view, it is the 'tacitness' content of knowledge that makes the contacts and the interactions generated by international activities crucial to enhance a firm's ability to do research and to develop innovations.

Another relevant channel of knowledge transmission which has been widely emphasized by the literature and is focused on the role of the firm, is the one that operates through MNEs inward and outward activities, e.g. through labour mobility, technical assistance, reverse engineering, intra group transfer of knowledge (for a review of the empirical evidence, see Breschi et al., 2005).

Finally, it is worth mentioning another activity that closely relates to innovation, that is to say imitation, according to which firms often are engaged in copying the designs and processes that competitors have already developed (Vernon, 1966; Segerstrom, 1991; Grossman and Helpman, 1991).[3] All the above mentioned channels add to the other internal and external innovation channels traditionally considered by the innovation and industrial economics literature (for a systematic review related to innovation in manufacturing, see Becheikh et al., 2006).

Turning now to the role of innovation as a determinant of trade, i.e. the other way causal relationship, the literature has stressed the mechanisms that work through dynamic comparative advantage or the product cycle theory (Vernon, 1966; Krugman, 1979), where the latter is focused on the concept of imitation. Moreover, the causal relationship from innovation to export has been recently emphasized by a new stream of the trade literature that has shifted its attention from sectors and products to firms. While there is a long tradition in the field of the economics of innovation and industrial economics that focuses on the firm and its characteristics as the core entity to investigate innovation's determinants and gains, it is only recently that the trade literature has been turning its attention to the firm. This literature (see Melitz, 2003), identifying in firm's heterogeneous characteristics and the role of sunk costs of exporting the primary determinants of internationalization activities, points to the *firm's self-selection* as the mechanism through which firms that are more efficient enter foreign markets because they are productive enough to bear the sunk costs of entry. Although this literature generally focuses on heterogeneity in productivity across firms, that is to say on intra-industry productivity differences, a recent number of contributions consider different heterogeneity dimensions, like the exogenous endowment in the ability to innovate or to upgrade product quality (Hallak and Sivadasan, 2007; Verhoogen, 2008). These contributions underline other channels through which export is related to innovation, pointing out that

[3] It is worth noting that due to the nature of firm-level survey data, a clear distinction between innovation and imitation is difficult to made at the empirical level unless patent applications or accreditation are used as dependent variables.

quality upgrading could be the best strategy for already innovating firms under certain assumptions.[4]

Finally, it is worth mentioning a recent contribution by Baldwin and Nicoud (2008) which investigates the impact of trade on innovation and growth in a macro-framework where firms are heterogeneous, that is to say the authors jointly consider the selection mechanism and some channels of international knowledge spillovers. In this framework openness may have anti-growth effects because it increases competition raising the fixed knowledge requirements of new products, but it may have pro-growth effects because it may reduce the price of knowledge by reducing its marginal costs through knowledge spillovers.

2.2 The firm-level empirical evidence

The focus on firm's characteristics recently emphasised by the trade literature has spurred a lively strand of empirical research that focuses on the relationship between internationalization and firm performance using firm-level data. The two-way causal link pointed out at the theoretical level translates into the two issues of 'endogeneity' and 'reverse causality' at the empirical level. When analysing the relationship between firm performance and internationalization, the problem of identifying whether the engine at work is either selection or learning becomes crucial. That is to say, given the widespread consensus on the evidence that internationalized firms perform better than the ones which operate only in the domestic market (Ottaviano and Mayer, 2007), it becomes policy relevant to clearly show whether 'better' firms self-select into international activities or whether involvement in foreign markets makes firms better, that is whether a post-entry learning mechanism is at work. Of course, the two mechanisms are not mutually exclusive and are likely to coexist, but for policy purposes it is crucial to distinguish the clear direction of the causality and the magnitude of the two causal effects. Indeed, if the causality runs exclusively from firm's performance (e.g., ex ante productivity or innovation) towards export, policies promoting trade liberalisation and export activities would have little scope if the goal is that of enhancing performance of existing firms. Trade would have in this case a positive effect on an industry and maybe a country aggregate performance, through selection, but not on firm level performance. On the other side, finding a positive effect of trade on the firm's competitiveness operating through learning instead of R&D expenditures, would be a much stronger implication. It would mean that policies promoting trade liberalization have a indirect effect on the firm's competitiveness which works

[4] E.g. when transportation costs are lower for higher quality goods, when low quality goods imply costs of negotiation over defective items, when some export markets impose minimum quality standards, when there are incomplete contacts and costs of international monitoring.

independently of R&D.

While in the empirical research there is a wide consensus that more productive firms self-select into international markets (among others Clerides et al., 1998; Bernard and Jensen, 2004), the evidence on *learning by exporting* effects on productivity is much more 'mixed'. However, some recent studies using rigorous empirical strategies have been able to identify positive causal effects of export activity on firm's productivity (see, for instance, Castellani, 2002; Greenaway and Kneller, 2007; Serti and Tomasi, 2007; Razzolini and Vannoni, 2008).[5] These studies focus on the relationship between productivity and export. In the literature total factor productivity (TFP), labour productivity and average variable costs are used as proxies for 'innovation'. Nevertheless it must be underlined that the relationship between productivity and product innovation is not that clear (among others Parisi et al., 2006; Salomon and Shaver, 2005). Moreover, many different factors other than innovation may affect the above mentioned proxies of productivity, in particular the interpretation of TFP has been questioned by several contributions (see, for instance, Katayama et al., 2003).

As to the contributions which have considered the relationship between export and innovation using direct information on the innovation activity of the firm, most of the literature has investigated whether innovation induces export (Wakelin, 1998; Sterlacchini, 1999; Basile, 2001; Roper and Love, 2002; Lachenmaier and Woessmann, 2004; Becker and Egger, 2007; Cassiman and Martinez-Ros, 2007, among others) rather then the reverse causal relation. In particular, among these contributions Basile (2001), Lachenmaier and Woessmann (2004) and Cassiman and Martinez-Ros (2007) provide evidence of a positive causal effect of innovation on export activity, pointing out in that way that some selection is at work. The other cited contributions find a positive association between the two activities which could be interpreted either as learning or selection without clearly distinguishing between the two.

Among this literature, it is worth mentioning some empirical evidence shown by the recent contributions already cited, Hallak and Sivadasan (2007) for manufacturing in India, Chile and Colombia, Kugler and Verhoogen (2008) for manufacturing in Colombia and Verhoogen (2008) for manufacturing in Mexico. The aim of these papers is to evaluate the impact of unobserved heterogeneity in quality (where quality depend on the exogenous ability in upgrading product quality) on export status. A positive correlation is found between the proxies of quality (output prices, skill employment composition, workers' ability, capital intensity and ISO 9000 certification) and the export status, while only Hallak and Sivadasan (2007), by using panel data for Chile and Colombia find that no learning effect seems to

[5] For a recent exhaustive review of the literature on the causal relationship between export and productivity at firm-level data see Wagner (2007).

emerge.

Research on the reverse causal relation (i.e. from export towards innovation) is very scant. A recent contribution by Liu and Buck (2007) evaluates the main channels which have been traditionally recognized by the literature as a source of international technology spillovers, together with domestic channels like R&D investment. The analysis is carried out by using a panel of sub-sector level data for Chinese high-tech industries, and new products are defined as either a novel or improved products. The authors consider three main channels of international spillovers: R&D activities of foreign MNEs, export sales and expenditure on imported technology. These variables together with domestic R&D intensity are then interacted with a proxy of absorptive capacity (the share of scientists and technicians on total employement). They show a positive and significant causal effect of all the interactions between absorptive capacity and the three channels on product innovation, while only export remains positive and significant taken by itself. The role of absorptive capacity emerges as determinant for import of technology and foreign R&D activities to induce an improvement in domestic innovative activity. It is worth noting that while domestic R&D looses significance when the other variables are introduced, firm size remains one of the most relevant determinant of innovation in all the specifications. A second contribution Salomon and Shaver (2005), using firm-level data, finds evidence of *learning by exporting* considering product innovation for Spanish manufacturing firms from 1990 to 1997. Information on product innovation is drawn from a survey where firms self-report the number of new or better products and the number of patent applications. The authors find a positive causal effect of both export status and export volumes on innovation performance, conditional on the firm's size, R&D expenditure and advertising intensity. In particular, the increase in product innovation takes place soon after exporting. In contrast to the previously mentioned contributions, size is never significant, while R&D expenditure and previous innovation have, respectively, a positive and a negative impact on innovation. Two other contributions provide evidence of the existence of a positive association between export and innovation without aiming at identifying causal effects Castellani and Zanfei (2007) and Gorodnichenko et al. (2008) [6] also considering other channels of technological transfer. Gorodnichenko et al. (2008) include among the determinants of innovation several proxies of different international spillover channels: export share, share of

[6]The focus of this paper is on the relationship between the higher competition induced by globalization and innovation, in particular by testing the main predictions derived by the recent contribution of Aghion et al. (2005). It is worth noting that while instrumenting the competition proxies, with regards to the trade variables the authors fail to identify a causal relationship between innovation and internationalization modes. In one of the specifications the authors use panel data to assess whether internationalization affects innovation, but in this specification they omit all the control variables.

imported inputs, pressure from foreign competition and the share of sales to MNEs. Both product and process innovations are considered as dependent variables. By using a firm-level survey on manufacturing and services for 27 transition countries, the authors find evidence of a positive correlation between all the internationalization modes and both product and process innovation. Moreover, it emerges that foreign and domestic competition have opposite impacts on the innovation activity of the firm, the former being positively correlated with innovation and the latter negatively. The basic Shumpeterian view that monopolistic market structure boosts innovation seems to hold for the domestic market while the predictions of the recent literature that competition enhances innovation holds for foreign markets. Innovation is also positively and linearly correlated with the size of the firm, while, in contrast with the previously mentioned contribution, the share of skilled workers does not seem to play any role. By using firm level data for manufacturing Italian firms Castellani and Zanfei (2007) analyses the correlation between three different modes of internationalization (export, MNEs controlling only non-manufacturing outside, MNEs controlling manufacturing plant abroad) and several different innovation measures. In particular, the authors can establish a ranking according to which exporters exhibit a higher propensity to introduce technological innovations and a higher share of workers in R&D than domestic firms, and MNEs with a manufacturing plant abroad perform better than exporters. Moreover two main channels of knowledge transfer emerge in the behaviour of the internationalized firms, the collaboration with the competitors for exporters and the technological collaboration within the group for MNEs.

From the three above mentioned contributions it emerges that export is an important channel of international technology spillovers, even when controlling for R&D expenditure and independently of a firm's absorptive capacity. The channels through which export positively impact on innovation, emphasised by these contributions, are the information exchange with foreign markets, through personal contacts with buyers and export intermediaries; the pressure of foreign competition is also found to have a positive impact, while the other traditional channel of international spillovers (information exchange with MNEs firms and knowledge embodied in imported technology) seems to be relevant especially when absorptive capacity is considered. Moreover, the role of R&D expenditure is confirmed to be positive and relevant in explaining innovation, while the evidence on size is more mixed.

3 The econometric strategy

The focus of the following discussion will be on the 'causal effect' of exporting on the probability of introducing product innovations at firm level, for firms that do export, that is the *average treatment effect on the treated* (ATT). A main problem that must be addressed to estimate this parameter is that of potential endogeneity of export status with respect to the output of innovating activity, that is a problem of firm's *self-selection* into both export activity and product innovation. For instance, highly productive firms might be more competitive in foreign markets, and therefore sell their goods abroad, but at the same time they might also produce more innovations at parity of inputs in the innovation process. If this latent productivity is either unobservable or omitted from the econometric models, this would generate an endogeneity problem. In the following discussion we will mostly analyze under which assumptions the parameter of interest can be estimated.

In what follows we will refer to: INN, a dichotomic variable that takes value one if a firm introduced product innovations and zero otherwise, as our *outcome* of interest; EXP, a dichotomic variable that takes value one if a firm exported and zero otherwise, as our *treatment* variable; X as a vector of *controls* (or control variables), that is variables that might affect both innovation and export; Z as the *instruments*, variables affecting export status only.

We start the discussion using as a benchmark a simple single equation linear model in which the likelihood of introducing product innovations INN depends on export status EXP, a vector of controls including both time-varying and time-invariying observable characteristics X and some unobservable characteristics that enter the error term u, that is:

$$\mathsf{INN} = a_0 + a_1 + a_2\mathsf{EXP} + a_3\mathsf{X} + u \tag{1}$$

where at this stage we have neglected the timing of the outcome, the treatment and the control variables and dropped the subscript for firms. We will refer to this model as the linear probability model (LPM, hereafter). For the sake of simplicity, at the moment we are assuming homogeneous export effects on innovation, that is 'homogeneous export premia'. We also assume that $E(u|\mathsf{X}) = 0$, that is controls are uncorrelated with the error term (i.e., they are exogenous), and that there are not general equilibrium effects, that is the outcome for a firm does not depend on the treatment status of other firms.[7]

Model (1) can be estimated using ordinary least squares (OLS). The conditions under which OLS provide consistent estimates are $E(u|\mathsf{X}, \mathsf{EXP}) = 0$ that is the error term is uncorrelated with the variables included in the right hand side (RHS) of equation (1). In case this assumption holds (and export premia are homogeneous), then the OLS estimate of a_2 also gives the *average treatment effect* (ATE), that is the average effect on innovation that would be produced by exporting on all firms, both exporters and non-exporters.

[7]The so-called stable unit treatment value assumption (Angrist et al., 1996).

Depending on the richness of the data available, this assumption might appear more or less strong, as a number of potential determinants of both innovation and export might have been omitted from the model, enter the error term u and generate a correlation between EXP and u. In such situation OLS is no longer appropriate and the estimation of causal effects requires a different strategy.

Before continuing the discussion, let us assume that export status EXP is in turn the outcome of a firm's decision which will depend also in this case on observable (X and Z) and unobservable characteristics (ϵ), that is:

$$\mathsf{EXP} = b_0 + b_1\mathsf{X} + b_2\mathsf{Z} + \epsilon \tag{2}$$

where Z are variables affecting only EXP but not INN, the so-called 'excluded instruments'. In case $E(u|\mathsf{EXP},\mathsf{X}) \neq 0$, a consistent estimate of the ATT could be obtained using instrumental variables (IVs), while OLS gives inconsistent estimates. In order for the IV strategy to work a number of further assumptions are needed (see Angrist et al., 1996): 1) the orthogonality condition, that is $E(u|\mathsf{Z},\mathsf{X}) = 0$; 2) the exclusion restriction assumption, that is conditional on the X the instrument has only an indirect effect on the outcome, through the treatment $E(\mathsf{INN}|\mathsf{Z},\mathsf{EXP},\mathsf{X}) = E(\mathsf{INN}|\mathsf{EXP},\mathsf{X})$; 3) the nonzero average causal effect of Z on EXP, that is $E(\mathsf{INN}|\mathsf{Z} = z_0) - E(\mathsf{INN}|\mathsf{Z} = z_1) \neq 0$; 4) the monotonicity assumption, i.e. if $z_1 > z_0 \Rightarrow E(\mathsf{INN}|\mathsf{Z} = z_1) > E(\mathsf{INN}|\mathsf{Z} = z_0)$. Under all these assumptions the IV estimator allows to recover the ATT.

Up to now we have assumed homogeneous 'export premia'. In reality, the innovation returns to exporting might differ across firms, both according to observable and unobservable characteristics. Here we limit our discussion to the the second case as the first one does not pose particular economic problems (since it is sufficient to correct the specification by including appropriate interaction terms). In case of heterogeneous returns equation (1) can be rewritten as:

$$\mathsf{INN} = a_0 + a_1 + (a_2 + a_i)\mathsf{EXP} + a_3\mathsf{X} + v_i \tag{3}$$

where we have introduced the firm's subscript i. In this case the coefficient on EXP becomes random. In such a situation we may have two possible cases: 1) firms do not self-select into export status according to their heterogeneous returns (i.e. $E(a_i|\mathsf{Z},\mathsf{X},\mathsf{EXP} = 1) = E(a_i|\mathsf{X},\mathsf{EXP} = 1)$); 2) firms do self select into export status according to their heterogeneous returns (i.e. $E(a_i|\mathsf{Z},\mathsf{X},\mathsf{EXP} = 1) \neq E(a_i|\mathsf{X},\mathsf{EXP} = 1)$). In the first case and in the presence of correlation between the error terms in the innovation and export processes, IVs allow to recover the ATT. In the second case, only if this is the sole source of self-selection (i.e., $E(v_i|\mathsf{Z},\mathsf{X}) = E(v_i|\mathsf{X}) = 0$), OLS allow to recover the ATT. By contrast, IVs enables to recover the so-called *local average treatment effect* (LATE) on the treated. The LATE is the effect on the firms whose treatment status (export status) is changed because of the different values taken by the instruments that define 'assignment' (see Angrist et al., 1996), who are usually referred to as *compliers*. This is often considered problematic in case a single instrument or very specific instruments, which are likely to affect only particular individuals or firms, are used, since using IVs would imply to estimate the effect of the treatment on an unobservable and very specific subpopulation. However, in Section 5 we will use as instruments some characteristics that are likely to affect the export status of most firms (such as distance from potential export markets), which will make us less prone to the above mentioned criticism.

As to the timing of both the outcome and treatment variables, we will consider the effect of export status in 2000 on the likelihood of introducing product innovations in the period 2001-2003. Considering lagged export status makes it predetermined with respect to the outcome variable, avoids potential problems of reverse causality, and, in our opinion, allows enough time for the potential *learning by exporting* effect to manifest itself (cf. Salomon and Shaver, 2005). As to the control variables, they will generally refer to 2000 or to the whole period 1998-2000 whenever annual information is not available, and they will be therefore always predetermined with respect to the dependent variable.

4 Data

In the empirical analysis we use data from the 8th (1998-2000) and 9th (2001-2003) waves of the Survey of (Italian) Manufacturing Firms (*Indagine sulle Imprese Manifatturiere*, SIMF or Capitalia's survey hereafter) managed by the Capitalia banking group (formerly Mediocredito Centrale and now a member of the UniCredit group).

The survey collects information on a sample of manufacturing firms with 11-500 employees and on all firms with more than 500 employees. The SIMF has been repeated over time at three-year intervals and in each wave a part of the sample is fixed while the other part is completely renewed every time (see Capitalia, 2002, p. 39). This helps to analyse both variations over time for the firms observed in different waves (panel section) and the structural changes of the Italian economy, for the part of the sample varying in each wave. Like in many other surveys used in the empirical literature, also in the SIMF, due to its structure, medium and large firms are over-represented.

The data set gathers a wealth of information on: balance sheet data integrated with information on the structure of the workforce and governance aspects; information on innovation, distinguishing whether product, process or organizational innovations were introduced; information on investments and R&D expenditures; information on the firms' international activities (export, off-shoring and FDI flows by area); information on financial structure and strategies. In order to implement the empirical strategy outlined in Section 3 we need to select all firms appearing in both the 8th and 9th waves of the survey, which refers to 1998-2000 and 2001-2003 respectively. This can create sample selection issues as some firms in the panel section might drop out from the sample for different reasons, such as non-response, cessation of activity, drop of firm size under 11 employees, change of sector (cf. Nese and O'Higgins, 2007). Here, we limit ourselves to comparing the values of some key variables for our analysis in the single 8th and 9th waves and the 8th-9th wave panel.

Table 1 compares means and standard deviations for some key variables used in the empirical analysis. The 1998-2003 panel appears to be fairly representative of the 1998-2000 cross-section under several dimensions, although the firms in the panel are slightly larger and more R&D intensive, both factors which might positively affect product innovation.

Table 2 reports some panel descriptive statistics splitting the sample between exporters and non-exporters. It is immediate to note that exporters are much more likely to introduce product innovations and that exporters on average also differ with respect to non-exporters in a number of observable characteristics that could affect product innovation. Indeed, exporters are sensibly larger in size (their average size is about three-times that of non-exporters) and hugely differ in terms of R&D activity.

5 Endogeneity, instrumental variables and empirical results

The dependent variable in our empirical analysis is a dichotomous variable representing the answer to the following question in the 9th wave of Capitalia's survey: "*Did you introduce product innovations in 2001-2003?*".[8] The dependent variable INN takes value one in case of affirmative answer and zero otherwise. Our main independent variable of interest is export status in the 8th wave of Capitalia's survey, given by the answer to the question "*Did you export in 2000?*", which is represented by a dummy variable EXP that takes on value one in case of positive answer and zero otherwise.

We already said that lagging export status is useful to address potential problems of reverse causality, that is firms that are likely to export are those who innovate in the same period, and to take into account the potential lag with which a *learning by exporting* effect on innovation is likely to emerge.

Among the control variables Xs many potential determinants of both firm's innovating and exporting activity that are gathered by the Capitalia's survey were included in the econometrics models. In particular, in addition

[8] A 'product innovation' is defined as the introduction of a completely new product or a sensible improvement of an old product at firm-level.

to export status, we included in the right hand side of the innovation equation (1) as controls: regions fixed effects; a dummy for bordering on foreign countries; year of firm's constitution; type of legal form; group membership (1998-2000); dummies for mergers and acquisitions (1998-2000); dummies for foreign ownership (1998-2000) and a dummy for having performed FDI in 1998-2000 as proxies of network or vertical knowledge spillovers;[9] two-digit ATECO sector (1998-2000);[10] real production in 2000 to capture possible scale effects; real capital stock per worker in 2000 as a proxy for the degree of capital intensity of the firm; variation in real capital stock in 1998-2000 as a proxy for the new capital introduced in the firm which might embody more 'technological capital'; R&D intensity on employment in 2000 (the ratio between R&D employees and firm size) and the percentage of R&D expenditures born to introduce product innovations in 1998-2000, as a major input in innovating activity; the 'skill ratio' in 2000 (the ratio between non-production and production workers) and average labour costs in 2000 (average wages) as proxies of absorptive capacity which makes it easier both producing and adopting innovations or 'product quality'; ISO 9000 certification possessed in 1998-2000 as a proxy of process and product qualities;[11] the degree of the management decentralization in 2000 (the ratio of entrepreneurs, managers and cadres over the other employees) as a proxy of decentralized managerial styles which might promote innovation; unit labour costs in 2000 computed as the ratio between total labour costs and real production as a proxy of firm's competitiveness (or 'ability' à la Melitz) affecting both export and product innovation; dummies for participating in R&D or export consortia in 1998-2000; a dummy for having bought patents from abroad in 1998-2000.[12].

First of all, in order to decide which estimator is the most appropriate (OLS or IVs), we need to test whether firms' export status is endogenous with respect to product innovation. We already said that many unobservable or unobserved characteristics, such as firm productivity or latent firm

[9] The percentage of firms performing FDI flows is very low in Capitalia's survey: 2.13% in 1998-2000 and 3.56% in 2001-2003. The percentage of firms which realize some production abroad is only available in 2001-2003 and is 7.42%. The percentage of firms exporting is much higher, being 68.15% in 2000 (8th wave) and 74.82% in 2003 (9th wave).

[10] ATECO stands for *Classificazione delle attività economiche*, that is an Italian classification of econonomic activies (i.e. industries) similar to the NACE European classification.

[11] Strictly speaking, certification to an ISO 9000 standard does not ensure the quality of end products and services rather, it certifies that consistent business processes are being applied.

[12] Real production was computed following Parisi et al. (2006) as the sum of sales, capitalized costs and the change in work-in-progress and in finished goods inventories deflated with the appropriate three-digit production price index provided by the National Statistical Bureau (Istat). Real capital stock was computed as the book value of tangible fixed assets appearing in the balance sheet net of depreciation and deflated by the price index provided by Istat (*beni strumentali*. Average labour costs were also deflated using three-digit industry deflators.

'product quality', if are omitted from the set of regressors may induce a positive correlation between export and introduction of product innovations. An endogeneity test for export status can be performed in an IVs framework. However, in order to implement it, we need credible instrumental variables. In particular, we need to find variables affecting export but not directly affecting firm's product innovation.

From economic geography, in particular gravity models, we borrowed the idea that firms' export status should be negatively and significantly correlated with geographic distance between a firm and potential destination countries, as transportation costs increase with distance. In particular, we have information about the province in which a firm is located, and it is therefore possible to compute the distance between the firm and export destination countries. Potential destination countries were identified by considering for each two-digit ATECO sector the first 25 countries in terms of export size to which Italy exports.[13] Country weights were determined by dividing the export to a specific country by the total sum of exports to all 25 countries by sector.[14] This implies that both destination countries and country weights are different across sectors. This procedure provides a sector-specific measure of distance, that is a measure of distance that varies across sectors that we call 'export distance' (EXPDISTANCE): two firms in the same province have different distances if they are in different sectors while two firms in the same sector and in different provinces have different measures of distance, due to their different geographical locations. As we have already said, both region and sector were included among the covariates in the innovation equation along with a dummy for being located in a border province, which help to reduce the risk that EXPDISTANCE could capture sector's or region's effects, or the effect of geographical proximity to foreign firms.[15]

Formally, EXPDISTANCE was computed as follows:

$$\mathsf{EXPDISTANCE}_{pi} = \sum_{j=1}^{25} d_{pj} \cdot w_{ij} \tag{4}$$

where d_{pj} is the distance between province p and country j and $w_{ij} = \frac{\mathsf{EXPORT}_{ij}}{\sum_{j=1}^{25} \mathsf{EXPORT}_{ij}}$ is the weight of country j in the total exports of sector i (on

[13]We do not use a finer disaggregation of ATECO mainly for two reasons: 1) coding errors increase when considering finer disaggregations; 2) exports are generally not available for all sectors/countries pairs when considering finer disaggregations.

[14]Data on export were taken from the OECD's STAN Bilateral Trade Database. Export weights refer to 1997 so as they are predetermined with respect to the period under study (1998-2003).

[15]The dummy for border province should capture the fact that border provinces might be more likely both to be influenced by knowledge spillovers from foreign firms and to export to neighboring countries.

the first 25 destination countries for sector i). Distances d_{pj} were computed using latitude and longitude of Italian provinces and foreign countries' capitals.[16]

We start by estimating an exactly identified model excluding only 'export distance' from the innovation equation. Hence, the main identifying assumption is that our sector-specific measure of distance affects product innovation only indirectly, through its effect on export status, while has no direct effect on product innovation. We think that controlling for sector and region fixed effects and including a dummy for border provinces in the innovation equation helps to make this assumption credible. Moreover, unlike knowledge spillovers from domestic firms, for which geographical proximity may matter as firms might learn from their neighbors, we think geographic distance should only have a very weak correlation, if any, with foreign knowledge spillovers once we control for the fact of having foreign firms as neighbors (i.e. being located in a border province). Last but not least, in the computation of 'export distance' we only considered the main *destination countries of Italian exports by sector*, which were weighed by the amount of exports, hence this variable should be highly correlated with export status (capturing the combined effect of transportation costs and sector comparative advantage) and eventual potential knowledge spillovers from exports and loosely correlated or uncorrelated with foreign knowledge spillovers taking place independently of export.[17]

Column (1) of Table 3 shows the estimates of the first-stage of IVs, that is the export status equation, using a LPM. The covariates explain overall the 22% of the whole variance in firms' export status. As expected, sector fixed effects (not shown in the table) are strong predictors of the likelihood that firms export.[18] Among the other significant variables, to be noted the percentage of R&D spent to introduce new products (at the 1% level), of R&D employment intensity (only at the 10%), of participating to an export consortium[19] (at 1%) which all have a positive correlation with exporting, and the negative correlation of our proxy of decentralized managing styles (at 1%). We find interestingly that unit labour costs are strongly negatively related to export status, while average firm's wages are positively related to

[16]These second set of coordinates was taken from the website http://www.cepii.fr/anglaisgraph/bdd/distances.htm. Distances were computed using the STATA module `sphdist` created by Bill Rising.

[17]Although this is far from being a formal test, when included in the LPM specification estimated with OLS of the product innovation equation EXPDISTANCE is not significant at the 10% level (p-value = 0.20).

[18]The complete set of these and following estimates is available upon request from the authors.

[19]Although in this case there might be a problem of reverse causality, since a firm can participate to an export consortium for two different reasons, to become an exporter or to increase its exports after entering foreign markets.

it.[20] We have seen that while the first is an indicator of firm's competitiveness, the second might be considered as a proxy of absorptive capacity or of product quality. Last but not least, the excluded instrument EXPDISTANCE is significant at the 1% level: a 100 Km reduction in 'export-distance' is associated to a 2% increase in the likelihood of exporting.

Column (1) of Table 4 reports the result of the estimation of the second stage of the model using IVs. Being the model exactly identified, it is not possible to test the appropriateness of our exclusion restriction. It is nonetheless possible to compute some diagnostics to test whether the excluded instrument is weak. Indeed, as well know, when instruments are weak IVs may be substantially biased. The partial F-test for EXPDISTANCE has a value of 13.70 which is above the threshold of 10 suggested by Staiger and Stock (1997.) to detect a weak instrument problem (in case of one instrument and one endogenous variable). The estimated effect of lagged export status is quite high, implying a 49 percent point premium in the probability of introducing product innovations for exporters, but not very precisely estimated and it turns out to be statistically significant only at the 10% level. In any case, both the Wu-Hausman F-test and the Durbin-Wu-Hausman Chi^2-test do not reject the null hypothesis of exogeneity of lagged (and hence predetermined) export status with respect to current product innovation. Hence, the low precision of the effect of export status might be due to the fact that under the exogeneity assumption IVs are consistent but inefficient.

Although the LPM compared to non-linear models such as probit or logit has the advantage of delivering consistent estimates of the effect of export status in case variables affecting innovation but uncorrelated with the former have been omitted from the model (see, Cramer, 2005), it has the well known pitfall that the predicted probabilities might fall outside the unit circle. For this reason we have also estimated a probit specification of the model whose results are shown in column (1) of Table 5. In particular, we estimated an IV-probit, where product innovation is modelled using a probit while export status is instrumented using a LPM.[21] In this case the estimate of the export premium is more precise and statistically significant at 5% with a magnitude (corresponding to a marginal effect of 44 percent points) similar to that obtained with the linear specification. The instrument also in this case does not seem to be weak (partial F-test=14.17). However, also in this case there is no evidence of an endogeneity problem, as the insignificant correlation coefficient (ρ in the table) between the error terms of the two equations suggests.[22]

[20] This last result is in line with a new strand of literature that introduces firm heterogeneity in the ability to upgrade product quality in a framework à la Melitz, which uses average wages as a proxy of this ability (see Hallak and Sivadasan, 2007).

[21] Hence, the first stage is common both to the IV and the IV-Probit specifications.

[22] We also estimated a bivariate probit specification, in which both product innovation

In order to check the robustness of the result of exogeneity of export status and to provide more evidence on the validity of our instruments, we also estimated an overidentified model. Column (2) of Table 3 reports the estimates of the first stage while column (2) of Table 4 the estimates of the second stage. We used as additional instruments the 1998 values of the unit labour costs and average wage levels, as proxies of firms' competitiveness (productivity) and 'product quality'. The identifying assumption is that once controlled for 2000 values of both covariates in the innovation equation, the excluded variables should not have any additional direct effect on introduction of product innovations between 2001 and 2003 while having a direct effect on firms' export status in 2000. The latter can be expected on the grounds of the high time persistence of export behaviour: lagged firms' characteristics might have induced them to enter the foreign markets before 2000 and remain in these markets after entering due to sunk costs.[23] Column (2) of Table 4 shows that the value of the F-test statistic (6.74) for the excluded instruments when compared with the critical values provided in Stock and Yogo (2002), for the case of three instruments and one endogenous variable, suggests that the set of instruments is not weak if we accept a 20% relative bias with respect to OLS (that is a maximum bias of IVs of 20% of those of OLS). The Sargan statistic suggests that our excluded instruments are valid (i.e. that they are uncorrelated with the error term and are correctly excluded from the product innovation equation). Also in this case, both the Wu-Hausman and the Durbin-Wu-Hausman tests do not reject exogeneity of export with respect to product innovation. Using an IV-probit estimator does not change these conclusions as shown in column (2) of Table 5.[24]

On the grounds of a robust evidence of exogeneity of lagged export status with respect to current product innovation, *conditional on several observables which are likely to affect both processes*, we decided to switch to models with exogenous export status. Column (1) of Table 6 reports the estimates for the LPM using OLS. Exporters are 14 percent points more likely to introduce product innovations than non-exporters. Some sector fixed effects (not shown in the table) are significant as expected, capturing different opportunities for innovation that characterize different industries. To be noted, the strong positive effect of having performed FDI flows in 1998-2000 on product innovation, which is larger than that of export, in line with Castellani

and export are modelled as probit, and obtained an insignificant correlation between the error terms also in this case. However, such a specification strongly relies on the joint normality assumption.

[23]Lagged export behaviour is not used as an additional instrument mainly since it requires using three waves of the SIMF (7th, 8th and 9th) which reduces the size of the panel and is likely to introduce a strong sample selection bias in the analysis (see Nese and O'Higgins, 2007).

[24]Also a bivariate probit leads to the same conclusions.

and Zanfei (2007). Significant positive predictors of product innovations are also R&D employment intensity, percentage of R&D spent for product innovations and investment in ICT, while unit labour costs are negatively related to product innovation. The effect of export status is sizeable. To have an idea of its magnitude the *ceteris paribus* difference in product innovation between exporters and non-exporters is higher than that between firms without an R&D lab and those with an R&D lab which accounts for 10% of total firm's employement. Column (2) of Table 6 shows the effect obtained using a probit specification. The significant covariates are the same found for the LPM specification and the effects are similar in magnitude too.

The negative correlation between unit labour costs and export and the negative one between the unit labour costs and product innovation suggests that a selection process à la Melitz (2003) might be at work: the most productive and competitive firms both export and introduce product innovations. Hence omitting unit labour costs or other important firm's characteristics that affect export status and product innovation in the same direction from the product innovation equation is could induce serious endogeneity problems.

6 Discussion of results

Given that there is a significant positive effect of export status on product innovation at firm level we might wonder what we are estimating, that is the 'pathways' of the estimated effect.

As it often happens, it is easier to say what our effect is unlikely to pick up rather than what it is really capturing.

We start by listing what our effect is unlikely to be:

- since in the product innovation equation we include controls for both R&D intensity and R&D expenditures borne to introduce product innovations, we can safely exclude that the effect of exporting is capturing internationalized firms' higher incentives to invest in formal R&D. The inclusion of patents acquisitions from abroad among the regressors let us also exclude that formal acquisitions of foreign technology by exporters is the main determinant of the observed 'export-premia' (spurious correlation). By contrast, we cannot exclude that export might be partly picking up the effect of pure R&D spillovers from export destination countries (i.e. informal channels);

- the inclusion of controls for performing FDI flows, contemporaneous to export, and a dummy for foreign ownership in the model, suggests that export status has an innovation-enhancing effect over and above other forms of firm's internationalisation, and that our effect is not simply picking up the effect of the latter (spurious correlation);

- after controlling for firm size and unit labour costs (which are likely to fall with firm's scale of production), we can exclude that export status is capturing a scale effect, that is the common incentive of larger firms both to enter foreign markets and to renew their products (spurious correlation). Similarly, we can exclude that the estimated effect of export is mediated by firm's market expansion due to export activities (causal pathway);

- since we control for proxies of absorptive capacity or product quality (such as the skill-ratio, average labour costs per worker, ISO 9000 certification), we can exclude that the effect of export that we estimated is mediated by product quality or workforce skill upgrading (causal pathways). We can also exclude that export is capturing the fact that firms with a more skilled labour force or which produce 'better' products self-select in both the exporting and innovating activities (i.e. spurious correlation);

We now engage in the harder task of discussing what our effect *might* be:

- as emphasized by the previous literature, exporting implies contact with foreign customers, being them final consumers or firms, and the exporting firm might need to change the specifics of its products in line with their needs. Firms may also have contacts with trade intermediaries providing information on potential customer's needs. All these contacts may then generate a knowledge spillover and increase firm's innovativity;

- we already said that our proxy for product innovation might has to do with imitation, that is a product might be new with respect to a firm but not with respect to the market. Hence, we cannot exclude that through engagement in foreign markets, a firm may acquire knowledge on customer's needs simply observing the production of foreign competitors and imitating their products. Also in this case we would have a foreign knowledge spillover;

- the competitive pressure might be tougher in foreign markets, fact which provides exporters with higher incentives to product innovation. In this case, the effect of export could either take the form of a spillover or of a higher firms' innovating effort at parity of R&D inputs (for which we control in the innovation equation).

As a future development of the current paper, we plan to explore this set of potential pathways from export to product innovation using information gathered by the Capitalia's survey.

7 Concluding remarks

In this paper we use data on Italian manufacturing firms and seek to identify the causal effect of firms' export status on their likelihood of introducing product innovations. Although our data set is rich enough to exclude that most of relevant determinants of export and product innovation have been omitted from the empirical analysis, a fundamental problem to be addressed is the one of potential endogeneity of exporting with respect to product innovation. Put it in other words, this is a problem of potential firm's heterogeneity and firm's self-selection according to unobservable (or unobserved) characteristics in both export and product innovations activities.

We make an attempt to address this problem using an IVs strategy and a variety of different econometric specifications. All the estimated models suggest an important positive causal effect of export on product innovation and tend to exclude exogeneity of the first, after conditioning on many potential confounding factors which are often not available in commonly used data sets.

Our preferred estimates, with exogenous export status, point to an 'export-premia' in the probability of introducing product innovations ranging between 14 and 16 percent points, obtained using a linear probability model and a probit model, respectively. Given the set of controls included in the econometric specifications, we can reasonably exclude that exporting is capturing exporters' higher incentives to invest in formal R&D or their formal acquisition of foreign knowledge through patents, or an effect mediated by workforce or product quality upgrading. By contrast, our findings are consistent with an effect of exporting that is generated by knowledge spillovers produced by contacts with foreign customers, trade intermediaries or competitors, or by a stronger competition in foreign markets, which provides firms with a higher incentive for product innovation. However, exploration of these causal pathways would require further analysis.

Overall, we conclude by saying that our analysis points to strong firms' *learning by exporting* effects on product innovation and is in line with recent findings by Salomon and Shaver (2005) although it is also consistent with a firm's self-selection process à la Melitz (2003) into exporting and innovation activities.

Tables

Table 1: Descriptive statistics for the Capitalia's 1998-2000 cross-section and the 1998-2003 panel

Variable	1998-2000 wave			1998-2003 panel		
	N. obs.	mean	s.d.	N. obs.	mean	s.d.
% exporters in 2000	4,667	0.679	0.467	2,047	0.681	0.466
% group members 1998-2000	4,667	0.205	0.404	2,044	0.201	0.401
no. employees 2000	4,675	87.561	364.198	2,050	97.231	417.150
capital intensity 2000$^{(a)}$	4,018	0.038	0.049	1,825	0.038	0.046
R&D intensity in 2000$^{(b)}$	3,814	0.015	0.392	1,735	0.020	0.551
skill-ratio 2000$^{(c)}$	4,675	0.347	0.184	2,050	0.336	0.173

Notes. $^{(a)}$ real capital stock per worker in thousands of Euros (at 2000 prices); $^{(b)}$ no. of R&D employees over total number of employees; $^{(c)}$ number of non-production (white collars) over production workers (blue collars).

Table 2: Descriptive statistics for non-exporters and exporters (1998-2003 Capitalia's panel)

Variable	N. obs.	mean	s.d.
Non-exporters in 2000			
% made product innovations in 2001-2003	642	0.241	0.428
% group members 1998-2000	651	0.144	0.352
no. employees 2000	652	41.095	164.193
capital intensity 2000$^{(a)}$	562	0.040	0.052
R&D intensity in 2000$^{(b)}$	544	0.003	0.011
skill-ratio 2000$^{(c)}$	652	0.319	0.178
Exporters in 2000			
% made product innovations in 2001-2003	1,371	0.508	0.500
% group members 1998-2000	1,390	0.227	0.419
no. employees 2000	1,395	123.636	490.921
capital intensity 2000$^{(a)}$	1,262	0.036	0.044
R&D intensity in 2000$^{(b)}$	1,190	0.028	0.666
skill-ratio 2000$^{(c)}$	1,395	0.345	0.170

Notes. $^{(a)}$ real capital stock per worker in thousands of Euros (at 2000 prices); $^{(b)}$ no. of R&D employees over total number of employees; $^{(c)}$ number of non-production (white collars) over production workers (blue collars).

Table 3: Probability of exporting in 2000 (linear probability model)

Variables	IV/IV-Probit (just-identified) (1)	IV/IV-Probit (overidentified) (2)
firm belongs to a group 1998-2000 (dummy)	-0.037	-0.036
	(0.030)	(0.030)
foreign ownership 199-2000 (dummy)	0.028	0.031
	(0.056)	(0.056)
variation in real capital stock 1998-2000	0.000	0.000
	(0.000)	(0.000)
per cent R&D to introduce new products 1998-2000	0.002***	0.002***
	(0.001)	(0.001)
firm belongs to an export consortium (dummy)	0.257***	0.261***
	(0.082)	(0.082)
firm belongs to an R&D consortium (dummy)	0.074	0.072
	(0.128)	(0.128)
FDI in 1998-2000 (dummy)	0.098	0.098
	(0.077)	(0.077)
bought foreign patents in 1998-2000 (dummy)	0.005	0.008
	(0.083)	(0.083)
invested in ICT 1998-2000 (dummy)	0.036	0.036
	(0.026)	(0.026)
size 2000 (no. employees)	0.000*	0.000*
	(0.000)	(0.000)
real capital intensity (K/L) 2000	-0.192	-0.203
	(0.261)	(0.261)
decentralized management 2000	-0.225***	-0.224***
	(0.064)	(0.064)
skill ratio 2000	-0.014	-0.016
	(0.080)	(0.080)
real unit labor cost 2000	-0.793***	-0.564***
	(0.115)	(0.164)
real cost per worker 2000	0.004***	0.004*
	(0.001)	(0.002)
R&D intensity on employment 2000	0.356*	0.361*
	(0.193)	(0.192)
ISO 9000 certification (dummy)	0.080***	0.079***
	(0.023)	(0.023)
export distance (100 Km)	-0.02***	-0.02***
	(0.005)	(0.005)
real unit labor cost 1998	-	-0.280**
		(0.134)
real cost per worker 1998	-	0.000
		(0.002)
Constant	3.605***	3.744***
	(1.147)	(1.151)
No. observations	1,622	1,622
R^2	0.22	0.22

Note. This table reports the first stage estimation of the export equation (LPM) that is common to both the IV and the IV-Probit estimates. P-values are shown in square brackets and standard errors in round brackets. Regressions also include controls for 2-digit ATECO sectors, regions, year of firm's constitution, dummy for bordering province, legal form, dummies for mergers and acquisitions. All real variables are in thousands of 2000 Euros. [a] correlation coefficient between the error terms in the product innovation and the export status equations.
*** p<0.01; ** p<0.05; * p<0.1

Table 4: Probability of having introduced product innovations in 2001-2003, IV linear probability models (LPM) with endogenous export status

Variables	IV (just-identified) (1)	IV (over-identified) (2)
firm exported in 2000 (dummy)	0.528*	0.409
	(0.306)	(0.257)
firm belongs to a group 1998-2000 (dummy)	0.072*	0.066*
	(0.037)	(0.035)
foreign ownership 1998-2000 (dummy)	-0.012	-0.010
	(0.065)	(0.063)
variation in real capital stock 1998-2000	0.000	0.000
	(0.000)	(0.000)
per cent R&D to introduce new products 1998-2000	0.002*	0.002**
	(0.001)	(0.001)
firm belongs to an export consortium (dummy)	-0.027	0.003
	(0.122)	(0.112)
firm belongs to an R&D consortium (dummy)	-0.144	-0.134
	(0.150)	(0.145)
FDI in 1998-2000 (dummy)	0.129	0.143
	(0.095)	(0.091)
bought foreign patents in 1998-2000 (dummy)	-0.104	-0.102
	(0.096)	(0.093)
invested in ICT 1998-2000 (dummy)	0.085***	0.089***
	(0.032)	(0.031)
size 2000 (no. employees)	0.000	0.000
	(0.000)	(0.000)
real capital intensity (K/L) 2000	-0.359	-0.388
	(0.309)	(0.298)
decentralized management 2000	0.049	0.024
	(0.098)	(0.090)
skill ratio 2000	0.015	0.009
	(0.093)	(0.090)
real unit labor cost 2000	0.056	-0.040
	(0.280)	(0.244)
real cost per worker 2000	-0.002	-0.001
	(0.002)	(0.002)
R&D intensity on employment 2000	1.154***	1.190***
	(0.240)	(0.228)
ISO 9000 certification (dummy)	-0.015	-0.005
	(0.037)	(0.033)
Constant	0.135	0.514
	(1.639)	(1.517)
No. observations	1622	1622
Partial R^2 excluded instruments ($\times$ 100)	0.87	1.15
F-test excluded instruments	13.70 [0.00]	6.09 [0.00]
Overidentification test[a]	-	0.64 [0.72]
Endogeneity tests:		
Wu-Hausman F-test	1.76 [0.18]	1.13 [0.29]
Durbin-Wu-Hausman Chi-square test	1.82 [0.18]	1.16 [0.28]

Note. P-values are shown in square brackets and standard errors in round brackets. Regressions also include controls for 2-digit ATECO sectors, regions, year of firm's constitution, dummy for bordering province, legal form, dummies for mergers and acquisitions. All real variables are in thousands of 2000 Euros. [a] Sargan test.

*** p<0.01; ** p<0.05; * p<0.1

Table 5: Probability of having introduced product innovations in 2001-2003, IV-probit models with endogenous export status

Variables	IV-Probit (just-identified) (1)	IV-Probit (over-identified) (2)
firm exported in 2000 (dummy)	1.377**	1.133*
	(0.641)	(0.641)
firm belongs to a group 1998-2000 (dummy)	0.184*	0.179*
	(0.095)	(0.097)
foreign ownership 1998-2000 (dummy)	-0.050	-0.047
	(0.176)	(0.179)
variation in real capital stock 1998-2000	0.000	0.000
	(0.000)	(0.000)
per cent R&D to introduce new products 1998-2000	0.004	0.005*
	(0.003)	(0.003)
firm belongs to an export consortium (dummy)	-0.064	0.011
	(0.330)	(0.327)
firm belongs to an R&D consortium (dummy)	-0.479	-0.472
	(0.393)	(0.401)
FDI in 1998-2000 (dummy)	0.399	0.450
	(0.299)	(0.293)
bought foreign patents in 1998-2000 (dummy)	-0.235	-0.242
	(0.266)	(0.271)
invested in ICT 1998-2000 (dummy)	0.239**	0.261***
	(0.107)	(0.101)
size 2000 (no. employees)	0.000	0.000
	(0.000)	(0.000)
real capital intensity (K/L) 2000	-1.035	-1.164
	(0.935)	(0.930)
decentralized management 2000	0.110	0.051
	(0.270)	(0.270)
skill ratio 2000	0.056	0.041
	(0.253)	(0.258)
real unit labor cost 2000	0.071	-0.174
	(0.759)	(0.721)
real cost per worker 2000	-0.005	-0.004
	(0.005)	(0.005)
R&D intensity on employment 2000	3.152***	3.382***
	(0.948)	(0.852)
ISO 9000 certification (dummy)	-0.046	-0.023
	(0.096)	(0.095)
Constant	-0.757	0.171
	(4.397)	(4.367)
No. observations	1,621	1,621
F-test excluded instruments	14.17 [0.00]	15.49 [0.00]
Overidentification test[a]	-	0.58 [0.75]
Endogeneity test:		
ρ^b	-0.413 (0.286)	-0.306 [0.279]

Note. The table reports coefficient estimates for the IV-probit models. P-values are shown in square brackets and standard errors in round brackets. Regressions also include controls for 2-digit ATECO sectors, regions, year of firm's constitution, dummy for bordering province, legal form, dummies for mergers and acquisitions. All real variables are in thousands of 2000 Euros. [a] Amemiya-Lee-Newey minimum Chi-square statistic (Lee, 1992); [b] correlation coefficient between the error terms in the product innovation and the export status equations.

*** p<0.01; ** p<0.05; * p<0.1

Table 6: Probability of having introduced product innovations in 2001-2003, models with exogenous export status

Variables	OLS (1)	Probit (2)
firm exported in 2000 (dummy)	0.141***	0.157***
	(0.027)	(0.030)
firm belongs to a group 1998-2000 (dummy)	0.055	0.061
	(0.034)	(0.039)
foreign ownership 1998-2000 (dummy)	-0.006	-0.014
	(0.063)	(0.070)
variation in real capital stock 1998-2000	0.000	0.000
	(0.000)	(0.000)
per cent R&D to introduce new products 1998-2000	0.002***	0.003***
	(0.001)	(0.001)
firm belongs to an export consortium (dummy)	0.071	0.083
	(0.087)	(0.103)
firm belongs to an R&D consortium (dummy)	-0.109	-0.153
	(0.166)	(0.156)
FDI in 1998-2000 (dummy)	0.172**	0.219**
	(0.070)	(0.089)
bought foreign patents in 1998-2000 (dummy)	-0.099	-0.091
	(0.088)	(0.093)
invested in ICT 1998-2000 (dummy)	0.099***	0.114***
	(0.028)	(0.032)
size 2000 (no. employees)	0.000	0.000
	(0.000)	(0.000)
real capital intensity (K/L) 2000	-0.453*	-0.547
	(0.265)	(0.343)
decentralized management 2000	-0.034	-0.043
	(0.059)	(0.080)
skill ratio 2000	-0.005	0.000
	(0.088)	(0.100)
real unit labor cost 2000	-0.256**	-0.311**
	(0.122)	(0.148)
real cost per worker 2000	-0.000	-0.000
	(0.002)	(0.002)
R&D intensity on employment 2000	1.270***	1.469***
	(0.212)	(0.280)
ISO 9000 certification (dummy)	0.017	0.016
	(0.026)	(0.029)
Constant	1.371	-
	(1.241)	
No. observations	1,622	1,621
R^2/Pseudo R^2	0.18	0.14

Note. The table reports coefficient estimates and marginal effects for OLS and Probit models, respectively. P-values are shown in square brackets and robust standard errors in round brackets. Regressions also include controls for 2-digit ATECO sectors, regions, year of firm's constitution, dummy for bordering province, legal form, dummies for mergers and acquisitions. All real variables are in thousands of 2000 Euros.

*** p<0.01; ** p<0.05; * p<0.1

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