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Are Exporters More Likely to Introduce Product Innovations?

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1. INTRODUCTION AND MOTIVATION

THE positive association between a firm's export status and its innovation can be considered as a strong empirical regularity in both international economics and the economics of innovation.

While a wide consensus has been reached on the fact that firms introducing product or process innovations are ex-post more likely to export (see, among others, Sterlacchini, 1999; Basile, 2001; Roper and Love, 2002; Lachenmaier and Woessmann, 2006; Becker and Egger, 2009; Cassiman et al., 2010; Cassiman and Golovko, 2011), evidence for learning by exporting is relatively recent and much sparser. In the literature, there are studies that do find a positive effect of a firm's export status only on process innovation (Damijan et al., 2010) but not on product innovation, studies that find an effect on product innovation (Salomon and Shaver, 2005; Liu and Buck, 2007; Fafchamps et al., 2008) but do not investigate process innovation and studies finding an impact on both types of innovation (Lileeva and Trefler, 2010; Bustos, 2011).

In this paper, we focus on a firm's export status and on a direct measure of product innovation, that is, a firm's likelihood of introducing a new or an improved product, to investigate *learning by exporting*.

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Although we will not study process innovation in great detail, we will nonetheless consider potential 'complementarities' between product and process innovation. Our analysis should be seen as complementing other studies on learning by exporting focusing on different measures of innovation, such as R&D, or productivity,[1] and the large number of studies that have already focused on the reverse causal link, going from innovation to exporting.

A major challenge in the evaluation of the causal impact of a firm's export status on product innovation is to disentangle spurious correlations owing to unobserved heterogeneity from causality. More productive firms may for instance both self-select into international markets and be more innovative: the so called *self-selection hypothesis* (Melitz, 2003). More recently, some contributions (Costantini and Melitz, 2008; Iacovone and Javorcik, 2010) have argued that both innovation performance and export activity may be a consequence of the firm's previous decisions on R&D investment (a hypothesis labelled *anticipation effect*, *conscious self-selection* or *learning to export*).[2] To address this endogeneity concern, we use instrumental variables methods.

Product innovativeness is an informative indicator of a firm's economic performance, as recent empirical evidence has shown that product innovation produces benefits also at the firm level, on sales, employment (Hall et al., 2008) and – in some cases – on productivity (Crépon et al., 1998).

Using product innovation to assess learning by exporting is useful for several reasons. First, product innovation is relevant *per se* since it gives different information than other indicators such as productivity, which has been widely used in the economic literature.[3] Second, because, unlike R&D investment, it is a measure of the output rather than an input of innovation activities and represents an indicator of successful innovation efforts, not necessarily entailing an increase in either marginal or fixed costs of production. Moreover, unlike

[1] For a detailed literature review of the papers using productivity, see Wagner (2007); Greenaway and Kneller (2007).

[2] The recent contributions belonging to the New-New Trade Theory literature stress the self-selection mechanism, pointing out how firms that are ex-ante more efficient (or more innovative) enter foreign markets because they are productive enough to bear the sunk costs of entry (Kneller and Yu, 2008; Hallak and Sivadasan, 2009). Some contributions in this framework highlight that export activities may induce existing firms to invest in order to improve the quality of products to be sold in high-income countries (see, for instance, Verhoogen, 2008; Crinò and Epifani, 2009). Some others look at multiproduct firms (see, for instance, Bernard et al., 2010, 2011). Here, self-selection is not only across firms but also within firms across product lines: trade liberalisation increases productivity at the firm level by inducing firms' specialisation in product lines in which they are more efficient.

[3] The use of direct innovation measures overcomes some of the problems related to the interpretation of productivity measures. For instance, estimates of productivity using sales, which are common in the economic literature, often cannot distinguish between price (market power) and quantity (productivity) effects, because price and quantity data are not separately available.

other measures of innovation such as formal R&D expenditures, patent counts and literature citations, our measure captures also the innovations that take place without being patented, outside firms' formal R&D activity and those which are not cited.

This motivates also the specific interest in Italy: several surveys show that although few Italian firms do formal R&D investments, many of them introduce product innovations. Hence, using a direct indicator of product innovation may be particularly important when studying innovation in countries that structurally underinvest in research, where small- and medium-sized firms are prevalent – such as in Italy – and where innovation is likely to mainly be incremental (Santarelli and Sterlacchini, 1990). Our measure also has some limitations, for example, it only refers to innovation status, that is, it does not provide information on the intensive margin and has a subjective nature, which may introduce a measurement error in the variable. However, while information on the number of innovations is not available in the survey we use, we will assess the robustness of our results to alternative subjective measures of innovation in Appendix A2.[4]

We add to the existing literature, briefly reviewed in Section 2, in several respects. Our data set, the Survey of Italian Manufacturing Firms (*Indagine sulle Imprese Manifatturiere*, SIMF hereafter) described in Section 3, provides a wealth of firm-level information both on balance sheet items (such as physical capital intensity, labour cost) and on internationalisation and innovation activities.[5] This constitutes a double advantage with respect to some of the previous literature. First, we are able to include in the export status equation many firm characteristics that may affect both a firm's innovation capacity and its export status. This makes the assumption of selection only on the observables more likely to hold when we use ordinary least squares (see Section 4.a). In fact, a number of studies have adopted identifying strategies based on the same assumption (such as propensity score matching) without the availability of a similarly rich set of controls. These studies include, for instance, those using only the CIS (Community Innovation Survey), which lacks balance sheet data. Second, the inclusion of these controls enables us also to exclude some potential pathways for the causal effect of firm's export

[4] For a very detailed description of the pros and cons of the measure of innovation we use, see Lachenmaier and Woessmann (2006).

[5] For some related literature using the same data set, see, among others, Basile (2001), Parisi et al. (2006), Angelini and Generale (2008) and Benfratello et al. (2008). The SIMF questionnaire has been used as the basis for the new survey on firm level data, which has been recently carried out on seven European countries within the framework of the *European Firms In a Global Economy: Internal policies for external competitiveness* (EFIGE) project, a large-scale project funded by the EU commission under the FP7 programme.

status on product innovation, shedding new light on this apparent 'black-box' (Section 6).

We go one step further in the analysis and also allow for selection on the unobservables using instrumental variables methods (Section 4.b). We use as sources of presumably exogenous variation in firm's export status the geographic distance from most likely destination countries for a firm's exports – determined according to the average exporting behaviour of firms operating in the same industry at the national level – these countries' market potential, and lagged firm unit labour cost. Compared with two previously published studies using instrumental variables (IVs, hereafter) to assess the effect of export status on innovation, namely Lileeva and Trefler (2010) and Bustos (2011) for Canada and Argentina, respectively, we employ different 'instruments' that enable us to estimate effects that are more general, as they are not limited only to exports directed to the US, that is, the largest and richest economy in the world, or to adjacent countries (such as Brazil and Argentina for Bustos and the US and Canada for Lileeva and Trefler). This is policy-relevant, as the vast majority of European (and Italian) firms export to other EU countries, and one is likely to be interested in the 'average' effect of export status, not necessarily of exporting to the US or to a specific country.[6]

Our empirical analysis yields some interesting results. First, the positive association between export status and a firm's product innovativeness survives the inclusion of many observable characteristics that might produce a spurious correlation between the two. Second, when the issue of the potential endogeneity of the firm's export status is tackled using IVs, it is found to have a large positive effect on the probability of introducing product innovations. Third, as for the sources and pathways, we observe that the effect of being an exporter remains even after controlling for many covariates capturing a higher 'formal' R&D investment for innovation and the effect of scale and for other variables capturing a firm's absorptive capacity. Last but not least, we report some preliminary evidence showing that process innovation does not seem to be the main mediating factor in the export status–product innovation nexus: exporters are more likely to be product innovators even if they did not change their processes. On the contrary, there is a higher probability of exporters introducing process innovations only if they also introduced product innovations.

[6] In our estimation sample, 40.31 per cent of manufacturing exporters exported to at least one country among Canada, Mexico and the US in 2003 (detailed data on each country are not available) while 91.2 per cent exported to the EU15 area. In the EFIGE firm-level data set, covering seven European countries (Austria, France, Germany, Hungary, Italy, Spain and the UK), 31.86 per cent of firms exported either to the US or to Canada in 2008, while 91.91 per cent exported to the EU15 area (our computations on EFIGE data, for a description of the survey, see Barba Navaretti et al., 2011).

Although the data we use do not allow us to directly identify the sources of the estimated effect, our analysis leads us to exclude explaining it by the sources of innovation generally highlighted by most of the recent empirical and theoretical literature, such as the incentives to invest in formal innovation inputs (e.g. R&D) induced by a larger or a more competitive market, or the spillovers generated by the interaction with other researchers in a larger market. In the spirit of the 'demand/market as information' theories of the sources of innovation (Section 6), we advance the hypothesis that one possible source of the learning by exporting that we find may be cross-country heterogeneity, either in consumers' tastes or in the firms' needs for specific inputs.

As a matter of fact, what is produced for the domestic market may not necessarily meet foreign buyers' needs, and a firm may be forced to modify or improve its products in order to find a niche in a foreign market. We claim that the interaction with foreign buyers and possibly competitors may convey to the firm important information on their needs and on the characteristics of the foreign market, which is too expensive or difficult to collect otherwise.

The structure of this paper is as follows: Section 2 includes a brief survey of the literature on the links between exporting and product innovation; Section 3 describes the data used; Section 4 reports the core of our empirical analysis, which aims at estimating the causal effect of a firm's export status on its product innovativeness; Section 5 explores the potential complementarities between product and process innovation and reports some evidence on learning by exporting in the latter; Section 6 discusses the potential causal pathways of the effect we estimate and Section 7 summarises the main findings and conclusions.

2. FIRM-LEVEL EMPIRICAL EVIDENCE ON EXPORTING AND INNOVATION

A good starting point for understanding the potential innovation-enhancing effects of export activities is the micro-industrial literature on innovation.

This literature distinguishes between technology-push factors, how activities and resources devoted to research by the supply side of the market autonomously drive innovation, and demand/market pull factors, stressing how firm-level innovative activity is stimulated by the demand side of the market either in terms of market size or of flows of ideas generated by information about customers' needs.[7] These ultimate sources of innovation at the firm level also lie at the core of the main pathways through which export activities could promote the introduction of new or better products, as systematized – in a general

[7] For a systematic review related to innovation in manufacturing, see Becheikh et al. (2006); see also Section 6 below.

equilibrium framework where trade liberalisation affects innovation – in Grossman and Helpman (1991) and Aghion and Howitt (1998). Those pathways can be broadly grouped into scale or competition effects inducing firms to engage in higher research effort[8]; access to foreign knowledge, firms benefiting from spillovers from the supply side of the economy; cross-country income and state of technology differences that may generate the right incentive for the exporters to invest in innovative activities or, alternatively, which may convey crucial information.

As for the empirical literature related to the causal effect of exporting (export status or export intensity) on product innovation, we are aware of only a few studies.

Salomon and Shaver (2005), using firm-level data, find 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 volume on innovation, conditional on the firm's size, R&D expenditure and advertising intensity. In particular, the increase in product innovation takes place soon after exporting. Firm size is never statistically significant, while R&D expenditure and previous innovation have a positive and a negative impact on innovation, respectively. Liu and Buck (2007) consider the effect of three main channels of international spillovers – R&D activities of foreign MNEs, export sales and expenditure on imported technology – on product innovation. The analysis is carried out using a panel of sub-sector-level data for Chinese high-tech industries, and new products are defined as either novel or improved products (as in our paper). The authors find a positive and significant effect of all the interactions between a measure of absorptive capacity and the three internationalisation modes on product innovation; only the amount of exports remains positive and significant taken by itself. It is worth noting that while domestic R&D loses statistical significance when the other variables are included, firm size remains one of the most relevant determinants of innovation in all specifications. Fafchamps et al. (2008) use a panel of Moroccan manufacturers and find that product innovativeness is positively related to the length of exporting experience, which they interpret as an instance of learning by exporting. The authors explain this effect as the need of Moroccan firms – which are mainly specialized in consumer items such as

[8] According to the Schumpeterian approach (Aghion and Howitt, 1998; Aghion et al., 2005), (i) an increase in the size of the market and the associated increase in the monopolistic rent for successful innovators will provide incentives to raise the firm's R&D expenditure and (ii) an increase in the competitive pressure of the product market might force firms to innovate in order to survive. Foreign markets may represent an increase both in the size of the market and in the competitive pressure.

garment, textile and leather – to design products that appeal to foreign consumers. Damijan et al. (2010) explore the direction of causality between export status and product and process innovation for Slovenian firms. They use propensity score matching on cross-sectional data from several waves of CIS and on industrial panel data and find only a positive effect of export status on the probability of becoming a process – but not a product – innovator, and no evidence of a positive effect of lagged innovation on the likelihood of becoming an exporter. Recently, some studies have tried to assess the causal effect of export status using methods that do not rely on the Conditional Independence Assumption (CIA), that is, the assumption that selection is on observable variables only. Lileeva and Trefler (2010) use a IVs approach with a plant-specific tariff-cut instrument and find that Canadian plants that were induced by the US tariff cuts to start or increase exports engaged in more product innovation.[9] Finally, Bustos (2011) does not focus on firm's export status, but directly on the effect of a reduction of Brazilian import tariffs on Argentinian firms, showing a significant increase in technology spending and in dichotomous indicators of process and product innovation.

Our work differs from Liu and Buck (2007) in several respects, since we focus on firm-level data and our analysis is not limited to high-tech industries but covers the whole of manufacturing. This is important as in high-tech industries, most innovation is likely to be generated by formal R&D, which has however a very limited role for innovation in other industries and for small firms, and therefore for Italy which is characterized by the prevalence of small businesses and a specialisation in low-skill productions (Faini et al., 1999). Unlike Salomon and Shaver (2005) and Fafchamps et al. (2008), we do not use panel data estimators, but we dispose of a much richer set of controls in our data that enables us to make the *selection only on observables* assumption more credible and to shed light on the potential pathways that might explain the effect of export status that we estimate, or at least to exclude some. Moreover, we also use a different strategy to identify the effect of export status using IVs. This represents also the main difference with respect to Damijan et al. (2010), who rely on the CIA to estimate causal effects. Last but not least, we use different instruments – based on demand-pull and supply-push export factors – than Lileeva and Trefler (2010). The latter use the responses of Canadian plants to the elimination of US tariffs. This large tariff cut took place during the period covered by their data and caused a huge increase in Canadian exports to the US. However, the nature of their instrument makes it likely that their IVs

[9] Two other contributions provide evidence for the existence of a positive association between exporting and innovation without aiming at identifying causal effects: The study by Castellani and Zanfei (2007) which considers export status and the study by Gorodnichenko et al. (2010) which considers the export share along with other channels of technological transfer (import share, share of sales to multinational firms).

estimates identify the innovation effect only of exports to the US, which may not be easily generalized also to exports to other countries. Canada and the US, for instance, are two neighbouring countries,[10] and the US represent one of the richest and most sophisticated export markets in the world. In this respect, the innovation effect of export status may be particularly strong for this specific pair of countries. The instruments we propose, in contrast, are likely to affect the decision of Italian firms to export to a very wide range of foreign markets, not necessarily the closest or the richest ones.

3. DATA

In the empirical analysis, we use data from the 8th (1998–2000) and 9th (2001–2003) waves of SIMF currently managed by the UniCredit banking group (formerly by Mediocredito Centrale and later by Capitalia).

The survey is representative of the population of Italian manufacturing firms with more than 10 employees and collects information on a sample of manufacturing firms with 11–500 employees and on all firms with more than 500 employees.[11] 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 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.

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 (exports, off-shoring and FDI flows by geographic area) and information on financial structure and strategies.

To implement the empirical strategy outlined in Section 4, we need to select all firms appearing in both the 8th and 9th waves of the survey, which refer 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 various reasons, such as nonresponse, cessation of activity, drop of firm size under 11 employees or change of sector. Moreover, owing to the rotating structure of the panel, using more than two consecutive waves greatly reduces the number of firms appearing in the sample, exacerbating potential sample

[10] The same is true of Bustos (2011) who considers only two trading partners, Argentina and Brazil.

[11] Like most data used in the literature, SIMF is not representative of micro-firms (see, among others, Bernard and Jensen, 2004; Crespi et al., 2008; Bustos, 2011).

selection problems (cf. Nese and O'Higgins, 2007). That is the main reason why we use only two consecutive waves (the 8th and the 9th).

Here, we limit ourselves to comparing the values of some key variables for our analysis in the 8th wave and the estimation sample based on the 8th–9th wave panel. Table 1 reports means and standard deviations for these variables.

The estimation sample appears to be fairly representative of the 1998–2000 cross-section under several dimensions, although the firms in the panel are a bit smaller and more R&D intensive.

The dependent variable in our empirical analysis is a dichotomous indicator (INN) representing the answer to the following question in the 9th wave of SIMF: 'Did you introduce product innovations in 2001–2003?'

A 'product innovation' is defined as the introduction of a completely new product or of an important improvement of an old product at the firm level.[12] The dependent variable INN takes the value one in the case of a positive answer and zero otherwise.[13] INN clearly encompasses both radical and incremental innovation and both improvements of an existing product and the introduction of a new product. A product can be new to the market, but also only to the firm. What our innovation variable allows us to say is that we are considering only modifications generating a change in the product content and not only in the product 'image' (e.g. design or re-packaging). The question on innovation in the survey used in our analysis closely resembles the one asked in the Community Innovation Survey, a survey collecting data on different innovation dimensions in several European countries and widely used in innovation research; the survey question follows the methodological guidelines of the Oslo Manual (OECD, 1997). Similarly 'subjective' measures of product innovativeness are commonly used in the literature. For two very recent examples, see Lileeva and Trefler (2010) and Bustos (2011). We assess the robustness of our results to alternative measures of innovation in Appendix A2.

Our main independent variable of interest is export status in 2000, which is available in the 8th wave of SIMF's survey, given by the answer to the question 'Did you export in 2000?', which is represented by the dummy variable EXP that takes the value one for a positive answer and zero otherwise.

Lagging the export status is useful to address potential problems of reverse causality, that is, the fact that firms that are likely to export are those who

[12] In the survey, firms were not asked if they discontinued the production of old products. For this reason, we are not able to explore the effect of export status on the range of products produced by firms (cf. Bernard et al., 2010).

[13] It would also be interesting to estimate the effect of export intensity (the ratio between exports and sales) on product innovation. Unfortunately, this piece of information was not collected in the 8th SIMF wave from which we take the export status. A 10th wave of SIMF was released for the period 2004–2007 but because of changes in the questionnaire and severe non-response, the linkage between the 9th and the 10th waves is problematic, and we prefer to use data from the 8th–9th wave panel.

TABLE 1
Descriptive Statistics for the SIMF's 1998–2000 Cross-section and the Estimation Sample

Variable	*1998–2000 Wave*			*Estimation Sample*		
	No. obs.	*Mean*	*SD*	*No. obs.*	*Mean*	*SD*
Per cent exporters in 2000	4667	0.679	0.467	1635	0.684	0.465
Per cent group members in 1998–2000	4667	0.205	0.404	1635	0.187	0.390
Number of employees in 2000	4675	87.561	364.198	1635	69.091	166.813
Capital intensity in 2000[(a)]	4018	0.038	0.049	1635	0.037	0.046
R&D intensity in 2000[(b)]	3814	0.015	0.392	1635	0.032	0.063
Skill ratio in 2000[(c)]	4675	0.347	0.184	1635	0.335	0.171

Notes:
(i) The estimation sample is built matching the 1998–2000 and the 2001–2003 SIMF's waves.
(ii) [(a)] Real capital stock per worker in thousands of Euros (at 2000 prices); [(b)] number of R&D employees over total number of employees; [(c)] number of nonproduction (white collars) over production workers (blue collars).

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. Table 2 reports some panel descriptive statistics splitting the estimation sample between exporters and nonexporters.

In line with past findings, it is immediate to note from the raw data that exporters are much more likely to introduce product innovations and that on average they also differ from nonexporters in a number of observable characteristics that could affect product innovation. Indeed, exporters are considerably larger and strongly differ in terms of formal R&D activities.

TABLE 2
Descriptive Statistics for Nonexporters and Exporters (Estimation Sample)

Variable	*No. obs.*	*Mean*	*SD*
Nonexporters in 2000			
Per cent made product innovations in 2001–2003	516	0.233	0.423
Per cent group members in 1998–2000	516	0.151	0.359
Number of employees in 2000	516	39.010	165.546
Capital intensity in 2000[(a)]	516	0.039	0.049
R&D intensity in 2000[(b)]	516	0.017	0.058
Skill ratio in 2000[(c)]	516	0.323	0.182
Exporters in 2000			
Per cent made product innovations in 2001–2003	1119	0.498	0.500
Per cent group members in 1998–2000	1119	0.203	0.402
Number of employees in 2000	1119	82.963	165.635
Capital intensity in 2000[(a)]	1119	0.036	0.044
R&D intensity in 2000[(b)]	1119	0.038	0.065
Skill ratio in 2000[(c)]	1119	0.341	0.166

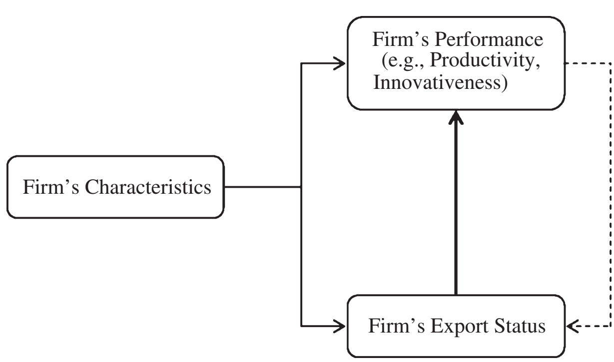
Note:
(i) [(a)] Real capital stock per worker in thousands of Euros (at 2000 prices); [(b)] number of R&D employees over total number of employees; [(c)] number of nonproduction (white collars) over production workers (blue collars).

4. ECONOMETRIC ANALYSIS

Figure 1 shows the potential sources of the positive association observed between a firm's export status and its performance, for instance, in terms of productivity or innovativeness.

The solid arrows on the right part of the figure show the self-selection argument: some observable or unobservable characteristics of the firm may positively affect both its innovation performance and its export status. One implication of this argument is that if we were able to observe and to control for all these potential firm characteristics, the positive correlation between export status and product innovativeness should disappear. This is what we will assess in Section 4.a, by including several firm characteristics that are likely to affect both export and innovation activities in a linear regression estimated using OLS and observe whether a positive correlation still survives. If this happens, it may be due either to a genuine causal effect of export status on product innovation (or to a reverse causal relationship, shown in the figure with the dashed arrows) or to some unobserved firm characteristics responsible for both outcomes. In this latter case, we have an endogeneity problem: the firm's unobservables may affect both export status and product innovation. A way to address this issue and to estimate the causal effect we are interested in, the one going from export status to product innovation (shown in the figure with the bold line), is by using an IVs strategy, that is, finding an exogenous source of variation in firm's export status. In Section 4.b, we will mainly use as a source

FIGURE 1
Sources of Association between Export Status and Firm's Performance



Note:
The solid arrows on the left side of the figure show a first source of (spurious) correlation between export status and firm's performance, represented by the self-selection in both activities according to both observed and unobserved firm's characteristics. The bold arrow shows a genuine causal effect going from export status towards product innovation. The dashed arrow shows a genuine causal effect going from firm's performance towards export status (reverse causality).

of identification a mixture of (domestic) supply-push and (foreign) demand-pull factors, related to, respectively, the nationwide pattern of Italian exports by industry and to features of the countries to which these exports are directed. This will also help solve the potential reverse causality problem shown with the dashed arrows in Figure 1.

a. Ordinary Least Squares

We formulate the following linear probability model (LPM) to estimate the probability that a firm introduces product innovations:

$$\text{INN}_{it} = a_0 + a_1\text{EXP}_{it-1} + a_2\text{X}_{it-1} + u_{it}, \tag{1}$$

where i and t are firm and wave subscripts. As we said in Section 3, we use cross-sectional data. However, the vector of the firm's control variables X_{it-1}, which might affect both innovation and export status, and the firm's export status $\text{EXP}_{it-1,}$ are both lagged one wave with respect to the dependent variable, to ensure that they are predetermined. A detailed description of the variables and their timing can be found in Appendix A1. u_{it} is an error term.[14]

In this section, we neglect the potential endogeneity of export status (with respect to product innovation) and use OLS. Our purpose here is simply to investigate whether the positive correlation between a firm's export status and its product innovativeness survives the inclusion of several observable characteristics that may be the source of a spurious correlation. The OLS results of specifications progressively adding covariates are shown in Table 3.

The idea is to control for potential correlates of export status, which might also affect the firm's innovativeness to make the selection only on the observables assumption more likely to hold.

In Model (1), which only includes export status, the estimated coefficient of export status on the likelihood of introducing product innovations is 0.265 and highly statistically significant.

Model (2) includes industry (2-digit ATECO sector[15]), in which a firm operates and its geographical location (region, i.e. NUTS 2). Both industry and

[14] As is known, the LPM has both advantages and disadvantages with respect to binary response models, such as probit or logit. The main advantage is that the LPM does not require assuming a specific distributional form for the error term u_{i} (e.g. normality in the case of the probit model), while the main disadvantage is that the predicted values are not constrained to be in the unit interval.

[15] ATECO stands for *Classificazione delle attività economiche*, that is an Italian classification of economic activities (i.e. industries) equivalent to NACE European classification.

TABLE 3
Probability of Introducing Product Innovations in 2001–2003 (Linear Probability Models Estimated with OLS)

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*
Exporter (d)	0.265***	0.206***	0.171***	0.135***	0.133***	0.133***	0.133***	0.133***	0.126***	0.136***
	(0.024)	(0.026)	(0.027)	(0.026)	(0.026)	(0.026)	(0.027)	(0.027)	(0.027)	(0.029)
Firm age			0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000
			(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Firm age missing			−0.040	0.018	0.029	0.028	0.031	0.028	0.028	0.071
			(0.147)	(0.146)	(0.148)	(0.148)	(0.148)	(0.146)	(0.148)	(0.166)
Group membership (d)			0.049	0.046	0.042	0.043	0.041	0.042	0.037	0.058
			(0.034)	(0.033)	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)	(0.040)
Spin-offs (d)			−0.027	−0.037	−0.039	−0.038	−0.042	−0.039	−0.032	−0.050
			(0.068)	(0.063)	(0.062)	(0.062)	(0.063)	(0.063)	(0.064)	(0.070)
Mergers or acquisitions (d)			0.085*	0.049	0.049	0.050	0.052	0.055	0.046	0.029
			(0.046)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.058)
Size			0.047***	0.043***	0.042***	0.042***	0.042***	0.041***	0.038***	0.059**
			(0.014)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.024)
Size squared			−0.002***	−0.002***	−0.002***	−0.002***	−0.002***	−0.002***	−0.002***	−0.005***
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)
Real capital intensity			−0.470*	−0.497**	−0.494**	−0.464*	−0.428*	−0.424*	−0.402	−0.497**
			(0.245)	(0.243)	(0.243)	(0.244)	(0.250)	(0.249)	(0.248)	(0.250)
Unit labour costs			−0.350***	−0.282**	−0.261**	−0.247**	−0.222*	−0.227*	−0.226*	−0.103
			(0.115)	(0.112)	(0.113)	(0.116)	(0.118)	(0.118)	(0.118)	(0.128)
Per cent R&D to introduce new products				0.002***	0.002***	0.002***	0.002***	0.002***	0.001**	0.002*
				(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)

TABLE 3 *Continued*

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*
R&D intensity on employment				1.297***	1.312***	1.307***	1.250***	1.250***	1.201***	1.674***
				(0.206)	(0.207)	(0.207)	(0.213)	(0.213)	(0.215)	(0.253)
R&D consortium				−0.103	−0.118	−0.122	−0.126	−0.122	−0.103	−0.105
				(0.164)	(0.162)	(0.163)	(0.159)	(0.160)	(0.156)	(0.144)
Invested in ICT (d)				0.101***	0.099***	0.099***	0.098***	0.098***	0.086***	0.094***
				(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.029)
Variation in real capital stock				0.002	0.002	0.002	0.002	0.002	0.002	−0.002
				(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)
FDI flows (d)					0.169**	0.168**	0.164**	0.163**	0.154**	0.173**
					(0.068)	(0.067)	(0.068)	(0.068)	(0.068)	(0.086)
Bought patents abroad (d)					−0.107	−0.107	−0.125	−0.121	−0.125	−0.099
					(0.091)	(0.091)	(0.092)	(0.093)	(0.095)	(0.118)
Foreign ownership (d)					−0.006	−0.009	−0.009	−0.008	−0.022	0.056
					(0.061)	(0.061)	(0.062)	(0.062)	(0.063)	(0.080)
Border province (d)					0.005	0.006	0.008	0.014	0.015	0.001
					(0.039)	(0.039)	(0.039)	(0.040)	(0.039)	(0.046)
Decentralised management						−0.023	−0.033	−0.034	−0.025	0.023
						(0.048)	(0.048)	(0.048)	(0.049)	(0.056)
Return on investment (ROI)						0.001	0.001	0.001	0.001	0.001
						(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Graduate ratio							0.398*	0.400*	0.390*	0.672***
							(0.214)	(0.214)	(0.217)	(0.259)

TABLE 3 *Continued*

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*
Real cost per worker							−0.001	−0.001	−0.001	−0.001
							(0.001)	(0.002)	(0.002)	(0.002)
Bank branches								0.002	0.002	0.002
per 10,000 pop.								(0.002)	(0.002)	(0.002)
Bank's functional								0.013	0.013	0.002
distance								(0.018)	(0.018)	(0.020)
Lagged product									0.123***	
innovation (d)									(0.032)	
Region fixed effects	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample										
All firms	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Product noninnovators in 1998–2000	No	No	No	No	No	No	No	No	No	Yes
R^2	0.063	0.109	0.125	0.178	0.181	0.181	0.183	0.184	0.194	0.184
No. obs.	1635	1635	1635	1635	1635	1635	1635	1635	1635	1232

Notes:
(i) Heteroskedasticty-robust standard errors in parentheses. Dummy variables are indicated with (d) after the variable. The specification in column (10) is estimated in the sample of product noninnovators in 1998–2000. All covariates are lagged. For a detailed description of the variables and their timing, see the Appendix A1.
(ii) *, **, ***Statistically significant at the 10, 5 and 1 per cent level, respectively.

geographical location are likely to have an effect on a firm's innovation and export status, for example, firms in certain industries may be more subject to foreign competition and have a higher incentive to introduce product innovations, or some specific regions may offer a better environment for both activities. Model (2) shows a reduction in the coefficient of export status, which falls to 0.206. Exclusion Wald tests show that industry is a much better predictor of a firm's product innovativeness than its geographical location: the corresponding *p*-values for the *F*-tests turn out to be 0.55 for administrative regions fixed effects and 0.00 for industry fixed effects. Despite this evidence, we keep the firm's geographical location in the specifications that follow, to avoid omitting potentially important local unobservable variables.

Model (3) controls for some observable dimensions of firm heterogeneity that are likely to be related to both innovation and export activities, such as firm age (and a dummy for missing age), a dummy for group membership, dummies for spin-offs and mergers or acquisitions, a quadratic in firm size (number of employees), capital intensity and unit labour cost. Age may have a twofold effect on innovation. On the one side, older firms accumulated the experience and knowledge necessary to innovate, suggesting a positive relationship between firm age and innovation. On the other side, older firms may have developed fixed procedures and routines that constitute a barrier to innovation (Becheikh et al., 2006). Group membership and mergers or acquisitions may be proxies of inter-firm knowledge flows, which are useful for innovation and export activities. Firm size, capital intensity and unit labour cost are proxies of firm productivity and are included to account for the potential self-selection of more productive firms into the export activity, that is, their ability to bear the sunk costs of entering foreign markets (Melitz, 2003). Firm size is also one of the variables most studied as a potential determinant of innovation since, according to the Schumpeterian approach (Aghion and Howitt, 1998), larger firms have an advantage in R&D because of a larger monopoly rent. Larger firms may also benefit from economies of scales in R&D. The dummy for group membership and the one for mergers and acquisitions are positively and significantly (at the 5 per cent statistical level) associated with product innovation, while unit labour costs are strongly negatively associated with firm's innovativeness. Both the linear and the quadratic terms in firm size are highly significant showing an inverse-U-shaped pattern of product innovation with firm size.[16] Physical capital intensity is negatively associated with product innovations, and the coefficient is statistically significant at the 10 per cent level. The coefficient on export status falls to 0.171.

[16] Interestingly enough, firm size is not significant if the quadratic term is not included. Hence, it appears to be crucial to allow for potential nonlinearities in the effect of firm size.

Model (4) introduces a set of technological inputs, which are likely to be strongly associated with firm's product innovativeness: R&D intensity on employment (number of R&D workers over firm total employment), the percentage of R&D spent on product innovations, a dummy for ICT investments, a dummy for participating to a R&D consortium and real investment in fixed capital, which could embody new technologies. We have already mentioned the learning-to-export hypothesis, according to which firms that plan to export are more likely to spend in R&D (Costantini and Melitz, 2008; Iacovone and Javorcik, 2010) or in information and communication technologies, and formal R&D is of course one of the most important determinants of innovation in the technology-push approach to innovation. All these new controls, except the last two, turn out to be significantly and positively associated with product innovation. The coefficient on export status experiences a noticeable drop, falling to 0.135, suggesting that part of the correlation between export status and product innovation is accounted for by technological variables and that firms that export also invest more in new technologies (ICT) or exert a higher formal innovative effort through R&D. Models (3) and (4) show that controlling for observed firm heterogeneity reduces the positive association between product innovation and export status.

Model (5) includes controls for other forms of international spillovers, in addition to those running through trade, such as the acquisition of foreign patents, a dummy for foreign ownership, a dummy for being located in a province bordering a foreign country and flows of FDI. 'Proximity' to foreign markets, for example, in the form of foreign ownership or geographical proximity, is likely to affect a firm's export status and may also give access to foreign knowledge useful for innovation. As firms carrying out FDI are often exporters and FDI affects innovation (Bertschek, 1995; Castellani and Zanfei, 2007; Gorodnichenko et al., 2010), it may be important to control for this variable in our regression. Among this new set of controls, only FDI flows turn out to be positively associated with product innovation, but the coefficient on export status is only slightly affected, falling to 0.133. This result is not unexpected as in our data, very few firms carry out FDI (<2 per cent in our estimation sample), while many firms export (about 68 per cent), and the correlation between the two activities is not large.[17]

[17] We also tried to include a dummy variable for making some production abroad, which is only available in the 9th wave of SIMF, and did find very similar results. The coefficient on export status becomes 0.132 with the same significance level. Given that we only have imperfect proxies of FDI stocks, and especially of delocalisation of production, for 1998–2000, we checked the robustness of our results by splitting the sample in two, between firms with no more than 25 employees, which are very unlikely to carry out FDI, and firms with more than 25 employees, and the coefficients on export status were very similar in the two subsamples.

According to the literature focusing on the determinants and the effects of the internal organisation of a firm, several indicators of the quality of Human Resource Management and the degree of decentralisation in decisions are strongly associated with firm's performance (Becheikh et al., 2006; Bloom and Van Reenen, 2007, 2010; Marin and Verdier, 2007). Model (6) accordingly includes some proxies of managerial quality and the degree of decentralisation in firm's decisions, proxied by the return on investment index (ROI) and by the ratio of entrepreneurs, managers and cadres over the total number of employees, respectively. Both variables are not significant, and the coefficient on export status does not change.

A firm's absorptive capacity may be a key factor in accessing and processing the new information necessary to implement successful internationalisation and innovation policies (Liu and Buck, 2007; Ito, 2011). Hence, model (7) introduces two proxies of firm's absorptive capacity: average labour cost and the percentage of graduates over total firm's labour force (i.e. the graduate ratio). The graduate ratio is significantly (at the 10 per cent statistical level) and positively associated with firm's product innovativeness, but the coefficient on export status is not affected.

Liquidity constrains may affect both a firm's export status (Bellone et al., 2010) and its innovation behaviour (Benfratello et al., 2008; Alessandrini et al., 2010). Model (8) controls for some proxies of the presence of firm's financial constraints, namely the number of bank branches over the population as a proxy of *operational distance* and a proxy of *functional distance* at province level (i.e. the average distance between a bank's head quarter and local branches at the province level).[18] Both variables turn out to be statistically insignificant, and the coefficient on export status does not change.[19]

Although model (8) represents our preferred specification, we also estimated a model including lagged product innovation status as an additional control variable, Model (9). This might be important to capture the potential dynamic structure of the process leading to product innovation. Indeed, it might be the case that firms that innovated in the past are both more likely to have exported in the past and to innovate in the future. For this reason, the coefficient on export status (in 2000) might be picking up the effect of *past product innovation* (during 1998–2000). However, our results show that even after controlling for past product innovation, the coefficient on export status is only marginally

[18] See Alessandrini et al. (2008) for the effect of both measures of distance on firms' financing constraints. We thank Pietro Alessandrini, Andrea Presbitero and Alberto Zazzaro who kindly provided data on banking.

[19] This finding is qualitatively consistent with Benfratello et al. (2008), which using the SIMF panel but controlling for a narrower set of covariates find a weak and not robust effect of the banking system's development on firm's product innovation, while finding a stronger effect on process innovation.

affected, falling to 0.126, and remains highly statistically significant. Lagged product innovation is positively and significantly correlated with current product innovation. These estimates suggest, overall, that past export status is at least as important as past product innovation for the probability of introducing product innovations.[20] As past product innovation could be endogenous, we make another attempt to account for the potential persistence (and serial autocorrelation) of product innovation status by estimating the specification in column (8) only in the sample of past noninnovators. The estimates are reported in column (10) and show a very similar association between export status and product innovativeness, which does not seem to be mainly driven by the persistence of innovation behaviour.[21]

Since we are using a subjective measure of product innovation, it may be important to check the robustness of our results to alternative innovation indicators. This is done in Appendix A2, in which we report some sensitivity analysis using other subjective measures of innovation.

From this first section of the empirical analysis, we can be quite confident that the positive association between a firm's export status and its product innovativeness is a robust one and survives the inclusion of an extremely rich set of observable firm characteristics that might have generated a spurious correlation.

Firms that exported in 2000 are *ceteris paribus* about 13 percentage points more likely to introduce product innovations in 2001–2003 than those that did not export, in our preferred specification (8).[22] However, nothing ensures that we might have omitted some unobservable variables that simultaneously affect both a firm's export and innovation activities and that the coefficient on export status may be simply picking up their effect. For this reason, in the next section, we make an attempt to address this problem, one of the potential endogeneity of export status, using an IVs strategy.

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[20] Some recent literature is stressing the role of imports on process and product innovation (Liu and Buck, 2007; Gorodnichenko et al., 2010) – for example, new inputs or import competition may stimulate product innovation – but unfortunately we do not have data on it. However, we built a proxy for a firm's import status, which is a dummy that takes on the value one if a firm bought transport or insurance services from abroad in 2001–2003, and zero otherwise – the information is not available for 1998–2000 – and included it in Model (8) as an additional covariate. The coefficient on export status is 0.127, statistically significant at the 1 per cent level, while the coefficient on the proxy for import status is 0.101, significant at the 5 per cent level. We also estimated specifications including import values merged by firm's industry-region cells using data from the *Istituto Nazionale per il Commercio Estero* (ICE, National Institute for Foreign Trade) to account for the different import intensity of regions and industries without any appreciable change in the estimates.

[21] Last but not least, to control for potential export and innovation spillovers at the region by industry level and for a different incidence of market concentration at the same level, we included region by industry fixed effects but the coefficient on export status was only slightly affected. These additional results are available upon request from the authors.

[22] Model (8) was also estimated using a probit specification. The marginal effect computed at the sample mean turns out to be 0.146, statistically significant at the 1 per cent level.

b. Endogeneity and Instrumental Variables Estimates

The identification of the causal effect of export status with IVs requires finding some excluded instruments, that is, variables providing an exogenous source of variation in a firm's export status.

As is well known, the negative correlation between distance and the amount of trade between countries (or smaller geographic units such as regions or provinces) commonly estimated in gravity equations represents one of the most robust empirical findings in international economics (Leamer and Levinsohn, 1995; Disdier and Head, 2008).

Recently, new developments in trade theory have stressed the role of firm heterogeneity, and gravity equations have accordingly been modified to include both the extensive (the number of exporting firms) and the intensive margins of trade (the amount of firm-level trade). Crucial for our paper is the idea that trade barriers, such as distance, affect not only the amount of goods sold by exporters but also the number of exporters, that is, the likelihood of being an exporter (Chaney, 2008; Helpman et al., 2008). Crozet and Koenig (2010), for instance, estimate a structural gravity equation, finding in almost all industries a large negative effect of the intra-national distance between French firms and adjacent foreign countries on the probability of exporting. We draw from these relatively recent theoretical developments and the related empirical literature to build a presumably exogenous source of variation in a firm's export status. In particular, we have detailed information on the province (NUTS 3) in which a firm is located[23] and use as an instrument the average distance from potential – not actual – destination countries for a firm's exports. Potential destination countries for a firm's products were identified by considering for each 2-digit ATECO industry the first 25 countries in terms of export value to which Italy exported in 1997.[24] The average distance is computed in the standard way in this literature, by aggregating values for single countries using export weights (see Bernard and Jensen, 2004; Lileeva and Trefler, 2010).[25] Individual countries' weights were determined by dividing the export value to a specific

[23] In Italy, in the period we study, there were 103 provinces.
[24] We do not use a finer disaggregation of ATECO mainly for two reasons: (i) coding errors increase when considering finer disaggregations and (ii) exports are generally not available for all industries/countries pairs when considering finer disaggregations. We consider the top 25 export destinations in analogy to Bernard and Jensen (2004).
[25] Bernard and Jensen (2004) use US export weights to compute an average real exchange rate for the US, while Lileeva and Trefler (2010) use US import weights from Canada to build an average tariff variable. Unlike the two papers above, however, we use a presample year to compute weights so that they will not be affected by export behaviour during the estimation period. Bernard and Jensen use average export shares between 1983 and 1992, their study spanning the period 1984–1992, and Lileeva and Trefler use the last year spanned by their data (1996).

country by the total value of exports to all top 25 countries by industry.[26] This implies that both destination countries and country weights are different across industries. The fact of considering export destinations and export weights at the national level, rather than at a more geographically disaggregated level (e.g. for regions or provinces), makes the instrument's exogeneity assumption more likely to hold. Nationwide export patterns should be less affected by region- or province-specific demand and supply shocks, which may also be correlated with individual firm's characteristics and behaviour. For the same reason, we consider the main destinations (the first 25), in terms of export value, so as destinations and weights are more likely to be exogenous with respect to the behaviour of single (perhaps large) firms.[27] This procedure enables us to compute an industry–province specific measure of a firm's average distance from its most likely export markets determined on the basis of the predetermined export behaviour of all Italian firms – not only those located in a specific province – which is a measure of distance that varies across industries and provinces and that we call 'export distance' (EXPDIST). Formally, EXPDIST was computed as follows:

$$\mathrm{EXPDIST}_{pi} = \sum_{j=1}^{25} w_{ij} \cdot d_{pj}, \qquad (2)$$

where d_{pj} is the great circle distance between province p and country j and $w_{ij} = \mathrm{EXPORT}_{ij}^{1997} / (\sum_{j=1}^{25} \mathrm{EXPORT}_{ij}^{1997})$ is the weight of country j within the total exports of sector i (to the first 25 destination countries for sector i).[28] We use as instruments both EXPDIST and its interaction with a dummy for firm size not >25 employees. The idea is that smaller firms have less resources with which to bear the fixed costs of entering foreign markets.

The second instrument that we propose is related to the idea of 'market potential'. We use a proxy of average export 'market potential' that is defined as:

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

[27] We also considered all potential destination countries but the instrument turned out to be weaker and the estimated effect less precise. In any case, since countries are weighted by their export share, destinations that are lower in the rank have very low weights and the instruments built in the two different ways are highly correlated. We also considered the first 25 (and all) export destinations by industry at the regional level using ICE data. In theory, this could have increased the precision of our instrument, at the cost of making the exogeneity assumption less credible for the reasons we already mentioned. However, also in this case the instrument turned out to be weaker. The reason is that the SIMF survey is not representative at the regional but only at the macro-area level.

[28] Great circle distance, which is commonly used in trade gravity models, is a raw measure of travel costs. For this reason, we also experimented in the first stage with a dummy for the presence in the province of airports, which unfortunately did not turn out to be statistically significant in the IVs first stage.

$$\text{MKTPOT}_{pi} = \sum_{j=1}^{25} (d_{pj})^{-1} Y_j, \tag{3}$$

where d_{pj} is the distance between province p and country j and Y_j may be either gross domestic product (GDP) in country j (Harris, 1954) or per capita GDP in country j (Friedman et al., 1992). Here, we use inverse distance weighted per capita GDP in 1997 evaluated at 2000 US dollars, summed across the first 25 destination countries for exports of sector i, obtained as described above for EXPDIST.[29] An alternative reason why per capita GDP may positively affect export status is that fixed entry costs are lower in richer countries (see Eaton et al., 2011, p. 1474).

However, market potential could also have direct effects on a firm's incentives to innovate. Here, we argue that these effects should be captured by research formal inputs, such as R&D intensity or the R&D devoted to the introduction of new products, which have been included among the covariates. Moreover, as for the previous instrument, we are considering only the top 25 destination countries to which Italy exports. The main idea is that the market potential of national exports by sector can affect a firm's likelihood to export, although a single firm has little control over it, that is, it should be exogenous with respect to product innovation at the firm level. Also in this case, as for EXPDIST, since per capita GDPs are weighted by the inverse of geographical distance, a crucial identifying assumption is that the firm's location is exogenous with respect to product innovation. In addition to MKTPOT, we also use as an instrument its interaction with a dummy for firm size not larger than 25 employees. The idea is that the economic returns to exporting to richer markets are greater for larger firms. In any case, as we use overidentified models (see below), we will be able to test for the instruments' validity.

The third instrument that we use is lagged unit labour cost, in 1998. According to New-New Trade Theory, higher productivity firms are more likely to self-select into the export activity (see, for instance, Melitz, 2003). In particular, lagged productivity is likely to affect lagged export status but should not have any additional direct effect on current product innovations between 2001 and 2003 after controlling for current productivity (proxied by current unit labour cost).

We use specifications with multiple instruments, that is, over-identified models, to test for their validity. IVs were implemented using two-stage least squares (2SLS).

In column (1) of Table 4, we report the results of the model using as excluded instruments export distance (EXPDIST), its interaction with a dummy

[29] We also tried with GDP, but the correlation with a firm's export status was much weaker in the first stage.

TABLE 4
Probability of Introducing Product Innovations in 2001–2003 (2SLS)

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
	All Firms	*All Firms*	*All Firms*	*All Firms*	*Older Firms*[(a)]	*Older Firms*[(a)]
1st stage: Export status equation						
Instruments:						
Export distance (EXPDIST)	−0.015***		−0.013***		−0.017***	
	(0.005)		(0.005)		0 .005)	
EXPDIST × size ≤25	−0.004***		−0.007***		−0.004***	
	(0.001)		(0.001)		(0.001)	
Market potential (MKTPOT)		0.149***		0.150***		0.151***
		(0.041)		(0.040)		(0.049)
MKTPOT × size ≤25		−0.033***		−0.050***		−0.029***
		(0.006)		(0.006)		(0.007)
Unit labour costs (1998)	−0.324**	−0.305*	−0.660***	−0.667***	−0.332**	−0.315**
	(0.159)	(0.157)	(0.189)	(0.192)	(0.152)	(0.151)
All controls	Yes	Yes	No	No	Yes	Yes
Only region and sector fixed effects	No	No	Yes	Yes	No	No
F-test instruments (p-value)	12.17	13.73	24.50	24.65	11.52	9.94
Partial R^2 instruments	0.023	0.025	0.068	0.072	0.023	0.23
2nd stage: Product innovation equation						
Exporter (d)	0.577***	0.558***	0.639***	0.628***	0.533***	0.549***
	(0.193)	(0.176)	(0.108)	(0.106)	(0.205)	(0.203)
All controls	Yes	Yes	No	No	Yes	Yes
Only region and sector fixed effects	No	No	Yes	Yes	No	No
Hansen J-statistic[(a)]	0.89 [0.64]	0.83 [0.66]	2.97 [0.23]	2.23 [0.33]	0.50 [0.78]	0.64 [0.73]
Anderson–Rubin–Wald test[(b)]	10.89 [0.01]	12.16 [0.01]	36.18 [0.01]	37.71 [0.00]	7.19 [0.07]	8.26 [0.04]
Endogeneity test[(d)]	5.03 [0.02]	6.21 [0.01]	18.17 [0.00]	18.20 [0.00]	4.11 [0.04]	4.82 [0.03]
No. obs.	1635	1635	1635	1635	1327	1327

Notes:
(i) Standard errors clustered at the province ×2-digit industry level in parentheses, p-values in brackets. Dummy variables are indicated with (d) after the variable. Only selected variables are reported in the table. The models also include all the covariates of Model (8) in Table 3.
(ii) [(a)] The estimation sample includes only firms established before 1990.
(iii) [(b)] Overidentification test. The joint null hypothesis is that the instruments are valid, that is, uncorrelated with the error term and that the excluded instruments are correctly excluded from the second stage.
(iv) [(c)] This test is robust to the presence of weak instruments and is valid also when observations are clustered. The joint null hypothesis is that the overidentifying restrictions are valid and that the coefficient on the endogenous variable in the structural equation (the second stage) is zero.
(v) [(d)] The endogeneity test is defined as the difference of two Sargan–Hansen statistics: one for the equation with the smaller set of instruments, where the suspect regressor is treated as endogenous, and one for the equation with the larger set of instruments, where the suspect regressor is treated as exogenous. The null hypothesis is exogeneity. This test, unlike the Durbin–Wu–Hausman test, is robust to various violations of conditional homoskedasticity and is suitable for our clustered data.
(vi) *, **, ***Statistically significant at the 10, 5 and 1 per cent level, respectively.

for firm size not larger than 25 employees and lagged unit labour cost. In the first stage, the first two instruments are significant at the 1 per cent level and the third one at the 5 per cent level.

Given the very high number of controls included, the partial R^2 of the excluded instruments is quite satisfactory, and the F-test is larger than 10 (see Bound et al., 1995). Hence, the excluded instruments we use appear to be highly relevant and have the expected sign: EXPDIST has a negative effect on a firm's export status, which is larger for smaller firms; unit labour cost negatively affects export status. The diagnostic tests reported in the bottom part of the table generally confirm the validity of the instruments. Indeed, according to the Hansen J-statistics, the joint null hypothesis that the excluded instruments are valid, that is, that they are uncorrelated with the error term and that they are correctly excluded from the estimated equation cannot be rejected.

The Anderson–Rubin–Wald test (Anderson and Rubin, 1949), which is robust to a potential weak instrument problem (Chernozhukov and Hansen, 2008), strongly rejects the joint null hypothesis that the overidentifying restrictions are valid, and the coefficient on export status in the second stage is equal to zero. The endogeneity test rejects the null hypothesis that export status is exogenous. In the second stage, export status appears to increase the likelihood of introducing product innovations by about 58 percentage points.

In column (2) of Table 4, we report the results of a model using a different set of instruments: MKTPOT, its interaction with a dummy for firm size not larger than 25 employees and lagged unit labour cost. Also in this case, all excluded instruments turn out to be highly significant in the first stage and with the expected sign. The joint F-test is 13.73 and the partial R^2 is 0.025. The diagnostic tests support the validity of the instruments and the endogeneity of export status. The Anderson–Rubin–Wald test shows that we cannot reject the null hypothesis that export status has a causal effect on firm's product innovativeness. The coefficient on export status is 0.558, very similar to the one obtained in column (1).

In columns (3) and (4) of Table 4, as a further check of the instruments' validity, we estimate with 2SLS a model only including region and industry fixed effects among the controls using the excluded instruments in columns (1) and (2), respectively, but excluding all the other firm characteristics.

Were the instruments endogenous – for example, should certain firms choose locations that are more favourable for both the innovation and the export activities (i.e. with lower values of EXPDIST or higher values of MKTPOT) – we would expect them to be highly correlated with firm characteristics, and 2SLS estimates in columns (3) and (4) to change radically from those in columns (1) and (2), respectively. However, this does not happen: the estimated coefficient on export status becomes only a bit larger.

Although all formal tests suggest that our instruments are valid, as the validity of EXPDIST and MKTPOT crucially hinges on the assumption that a firm's location is exogenous with respect to its propensity to innovation and exporting, as a further robustness check, we report in columns (5) and (6) the 2SLS estimates in the sample of firms that were established before 1990. These firms chose their location more than 11 and seven years before the year which the innovation outcome and EXPDIST and MKTPOT, respectively, refer to, and it could be argued that the assumption of exogenous location is very likely to hold in this subsample. The estimates of the treatment effects are very similar to those in columns (1) and (2).[30]

As is clear from the comparison between Tables 3 and 4, the IVs and OLS estimates strongly differ. In particular, the OLS estimates are much lower than the IVs estimates. A potential explanation for this difference is that in case of treatment effects heterogeneity, the treatment effects estimated using IVs can be given a local average treatment effects (LATE) interpretation: our 2SLS estimates combine several LATE obtained with the different instruments, where the single LATEs are the treatment effects for firms whose treatment status is affected by the instrument, and weights are proportional to the 'strength' of the instruments (Imbens and Angrist, 1994; Angrist and Imbens, 1995).[31] As we use several instruments that are related to the fixed costs of entering foreign markets (EXPDIST), the ability of firms to bear such costs (i.e. productivity, proxied by lagged unit labour cost) and the potential gains from entering these markets (MKTPOT), which are likely to affect the export status of a large number of firms, our estimates may be representative of the average treatment effects in the population (see Lachenmaier and Woessmann, 2006, p. 331). The fact that the IVs estimates obtained using different sets of instruments are very similar is quite reassuring in this regard. In any case, they are policy-relevant, as are the treatment effects they allow of identifying, as public interventions may be targeted at reducing firm's fixed costs of exporting, for instance, through publicly financed forms of export assistance (such as chambers of commerce) or at increasing firm productivity, by improving for instance the

[30] In model (5) the Anderson–Rubin–Wald test cannot reject the null hypothesis only at the 10 per cent level. In general, the estimate of the effect of export status becomes more imprecise when the sample size gets smaller, and rejecting the null that is zero also becomes more difficult.

[31] To be more precise, this interpretation is valid in case there are no covariates in the regression. If covariates are included, there is no simple interpretation for the IVs estimates using many instruments. However, if potential outcomes are linear in the covariates, the interpretation given in the text is preserved. Unfortunately, the size of our estimation sample does not enable us to further explore treatment effects heterogeneity by estimating subsample IVs. An alternative, not mutually exclusive, reading of our results is that the self-reported export status variable may be affected by a substantial measurement error, causing an attenuation bias.

efficiency and effectiveness of public services or by promoting labour market reforms.

5. 'COMPLEMENTARITIES' BETWEEN PRODUCT AND PROCESS INNOVATION

Some previous studies have also investigated the effect of export activities on process innovation. Just to take a few examples, Damijan et al. (2010) find evidence that export status affects the likelihood that Slovenian firms introduce process innovations; Lileeva and Trefler (2010) show that Canadian plants that were induced by the US tariff cuts to start or increase exporting had higher adoption rates of advanced manufacturing technologies; Bustos (2011) reports that falling Brazilian import tariffs raised the process innovativeness of Argentinian firms.

Van Beveren and Vandenbussche (2010) have suggested a strong complementarity between process and product innovation. In our context, for instance, firms engaged in foreign markets may acquire information on new and more efficient production processes, which once adopted will allow them to also change the characteristics of their goods and to produce new products.

In our sample, 692 (42 per cent) firms did not introduce either product or process innovations in 2001–2003, 266 (16 per cent) introduced only process innovations, 296 (18 per cent) only product innovations, and 381 (24 per cent) both product and process innovations.

Hence, a potential criticism of our empirical specifications in Section 4.a is that export status may affect mainly process innovation, which in turn affects product innovation. To put it in other words, process innovation may be a causal pathway (or a mediating factor) between export status and product innovation.

To shed light on these potential 'complementarities', we report in columns (1), (2), (3) and (4) of Table 5 the OLS coefficient of export status in the product innovation equation both in the whole sample and when the estimation sample is restricted to firms that did not introduce process innovations in 1998–2000, 2001–2003 and 1998–2003, respectively. The coefficient on export status is highly statistically significant in the restricted samples and very similar to the one found in the whole sample, suggesting that process innovation is probably not the main mediating factor in the relationship going from a firm's export status towards product innovation. In columns (5), (6), (7) and (8), we estimate models using the likelihood of introducing process innovation as the dependent variable in the whole sample and in the subsamples of firms that did not introduce product innovations in 1998–2000, 2001–2003 and 1998–2003, respectively. Column (5) shows that the point estimate

TABLE 5
'Complementarities' between Product and Process Innovation (OLS)

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
	Product Innovation				*Process Innovation*			
Exporter	0.133***	0.133***	0.111***	0.118***	0.056**	0.013	0.015	−0.019
	(0.027)	(0.033)	(0.030)	(0.036)	(0.028)	(0.031)	(0.032)	(0.035)
All controls		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample								
All firms	Yes				Yes			
Process noninnovators 1998–2000		Yes						
Process noninnovators 2001–2003			Yes					
Process noninnovators 1998–2003				Yes				
Product noninnovators 1998–2000						Yes		
Product noninnovators 2001–2003							Yes	
Product noninnovators 1998–2003								Yes
No obs.	1635	1232	958	808	1635	1624	1232	958

Notes:
(i) Models (1–4) use as the dependent variable a dichotomic indicator for having introduced product innovations, and models (5–8) a dichotomic indicator for process innovations. Standard errors in parentheses are robust to heteroskedasticity. The models for product innovation also include all the covariates of Model (8) in Table 3. The models for process innovation include the same controls except for the percentage of R&D devoted to new products, which is replaced with the percentage of R&D devoted to new processes.
(ii) *, **, *** statistically significant at the 10, 5 and 1 per cent level, respectively.

of the coefficient on export status is lower than the one in the product innovation equation in column (1).[32] Interestingly enough, when the estimation is restricted to the samples of product noninnovators, the coefficient is never statistically significant. This preliminary analysis seems, then, to suggest that product innovations may represent an important mediating factor in the relationship going from export status towards process innovation. To put this in

[32] However, the 95 per cent confidence intervals for the coefficient of export status are [0.0813, 0.1857] and [0.0005, 0.1114] in the product innovation and process innovation equations, respectively. Thus, the two coefficients are not statistically different at the 5 per cent significance level.

other words, some firms may adopt new processes as they need to renew their products.[33] A thorough analysis of learning by exporting in process innovation and a deeper assessment of the complementarities between product and process innovation would open new important issues, which we leave for future work.[34]

6. DISCUSSION

We have shown that export status positively affects the likelihood that a firm introduces product innovations. After controlling for several indicators of firm efficiency and quality, from the analysis in the previous section, we can say that we are capturing an effect that is over and above the common incentive of 'better' firms both to enter foreign markets and to renew their products. Nevertheless, it is worth mentioning that our results show a negative association of export status and product innovativeness with the main firm efficiency indicator (i.e. unit labour cost), in line with the self-selection mechanism emphasised by the recent empirical literature.[35]

At this point, we might wonder what is the source of the incentive for exporters to innovate and through which pathways this effect takes place. The literature investigating the sources of innovation at the firm level distinguishes between technology-push and demand/market-pull factors.

According to the first explanation are the activities and capabilities of the firm that drive innovation – mainly basic research and industrial R&D – while the second maintains that innovation is mainly spurred by the external

[33] We tried to estimate the process innovation equation using 2SLS and the two sets of excluded instruments used in Table 4, but in both cases the Hansen *J*-statistic rejected the null hypothesis that the instruments are valid. This may be due to the fact that, unlike for product innovation, 'closeness' to the main export markets may have a direct effect on the firm's adoption of new processes, that is, the exclusion restriction is not valid. This may happen because while exporting firms may be pushed to change their products to meet different foreign tastes, all firms may find it convenient to adopt new and more efficient production methods for their domestic production and therefore independently of their export status.

[34] Indeed, most research focusing on learning by exporting with respect to process innovation has also considered the effect of export status on productivity. Moreover, a full assessment of the complementarities between the two types of innovation would require estimating a multi-equation structural model in which they appear both as the dependent and the independent variable, and finding appropriate exclusion restrictions to identify the model.

[35] According to the learning-to-export hypothesis mentioned in Section 2, firms that plan to export start to increase their innovative effort mainly measured with formal R&D – but this could also extend to other forms of non-R&D innovation effort – before entering the foreign market. For evidence consistent with this idea, see, for instance, Van Beveren and Vandenbussche (2010). Since we are controlling for past R&D intensity and the share of R&D oriented to the introduction of new products – in some specifications also for past innovation – we think that it is unlikely that we are capturing this channel.

requirements of the market. This second approach looks in turn at the market/demand side in two different ways: (i) demand as size of the market or 'incentive effect' (Schmookler, 1966; Jovanovic and Rob, 1987; Sutton, 1998) and (ii) demand as information or 'uncertainty effect' (Myers and Marquis, 1969). This last stream of literature stresses the interaction with buyers as a source of information, which raises the innovative effort of the firm, and it underlines either the role of 'sophisticated' customers who can provide feedbacks to producers or the role of taste heterogeneity (Adner and Levinthal, 2001; Malerba et al., 2007).[36] Then, theoretically, both technology-push and demand-pull factors might explain the greater innovativeness of exporters.

In our empirical specifications, we control for many covariates that are likely to mediate the effect of export status on innovation in terms of higher formal innovative efforts such as investments in R&D, acquisition of foreign patents, and of new capital goods to produce different products. Moreover, we control for firm size and unit labour cost (which are likely to fall with the firm's scale of production). Our results are in line with the past literature showing an important role for most of these factors. Their inclusion as control variables allows us nonetheless to exclude that in our analysis export status is capturing either a scale effect or the effect of stronger competition on firm's formal research engagement.

A possible interpretation of the effect of export status, drawing from the literature on multiproduct firms (Bernard et al., 2010, 2011), is that it could produce a within-firm reallocation of resources and a change in the product mix. In particular, exporters could focus on their 'core competency'. As a consequence, firms that do export could specialize in fewer products, and, perhaps, have stronger incentives to keep them up-to-date ('scale per product' effect). Despite this being another potential channel for the effect of export status on innovation and a possible reading of our results, which we cannot completely rule out, we tend to exclude that this is driving all the effect in our specific case, since we control not only for total R&D intensity but also for the share of R&D devoted to introducing product innovations. On the grounds that exporters could be focusing their production on their 'core competency', R&D for product innovations should partly capture their higher incentives to renew these products. Moreover, owing to the characteristics of Italian manufacturing where small-size businesses are prevalent and formal R&D very rare (Table 2), there are possibly only a few exceptions in which firms have enough human resources to carry out R&D by product line.

[36] Several empirical studies support the role of demand/market pull factors, for instance those showing that market research aiming to gather customer feedback and to detect the evolution of customer needs, monitoring competitors and other marketing strategies are beneficial to innovation (Becheikh et al., 2006).

As we control for proxies of absorptive capacity (graduate ratio and average labour cost) and internationalisation modes other than exporting (FDI flows), which could represent some preferential ways to exchange information with foreign researchers, we tend to exclude results being mainly driven by technology-push factors. Then, the coefficient on export status is likely to capture other effects, which may take the form of pure knowledge spillovers, informal higher innovative effort or lower costs to gather information on foreign markets, which originate from the interaction with foreign customers. Export activities imply 'proximity' to foreign markets. This may reduce the cost of searching for successful innovation and of gathering information on the needs of foreign buyers and on the market location of competitors. As emphasized by the seminal contribution of Vernon (1966), advanced economies have the same access to scientific knowledge, but commercial innovation responds to demand. Proximity, which guarantees effective communication between the potential market and the potential supplier, is at the basis of the development of new products, owing to uncertainty and ignorance of the characteristics of the market. More recently, the search/network approach to international trade has highlighted the role of incomplete information, in particular when trade is in differentiated products. Buyers – both consumers of final goods and firms seeking inputs – may incur costs in discovering the characteristics of foreign varieties; buyers and sellers may not automatically match across countries and they may need to interact (see, for instance Rauch, 1996; Rauch and Trinidade, 2003; Rauch and Watson, 2003). On the other hand, the interaction with diverse foreign agents (both buyers and competitors) should facilitate processes such as the transfer of tacit knowledge or imitation.

We take this evidence to be consistent with the hypothesis that our results could be driven by 'demand as information' factors, that is to say, by the interaction with customers and/or competitors in the foreign market.

Unfortunately, in the SIMF data set, we do not have enough information to clearly single out the specific mechanisms at work. Having pointed out that interaction with foreign buyers (both firms and consumers) and possibly competitors may be a possible channel explaining the effect we find, we may wonder now what distinguishes the foreign from the domestic market.

Several contributions in the literature underline the role of cross-country differences in income and state of technology in driving product innovation, both through knowledge transfers and by generating the right incentives to innovate.[37] Since the largest part of Italian exports goes to economies characterised by similar levels of income and development, we doubt foreign taste for quality or superior technologies of foreign firms – probably more relevant for less

[37] For a comprehensive view of recent contributions, in particular on product quality and cross-country income differences, see for instance Baldwin and Harrigan (2011).

developed countries – is the driving force of product innovativeness of Italian exporters.[38]

Even among similar countries, nevertheless, there are several, not mutually exclusive, pathways through which foreign demand may stimulate exporters' innovative behaviour.

First of all, heterogeneity in consumer tastes across countries owing to cultural, geographic, ethnic and historical differences may represent an important incentive for firms that do export to introduce product innovations, that is, to modify or improve their products to meet foreign needs (Goldberg and Verboven, 2005; Ferreira and Waldfogel, 2010; Friberg et al., 2010).[39] It is worth noting that an exporter entering a new foreign market has to search for a niche in which to sell his production, this possibly implying changes in the characteristics of their product, not necessarily to meet diverse foreign needs but possibly to differentiate them from foreign competitors (Desmet and Parente, 2010). Heterogeneity in tastes may also generate heterogeneity in foreign firms' technological specificities, for example, the need to adapt intermediate goods, even across countries with the same state of technology. As a consequence, exporters supplying inputs to foreign buyers may have to customize their products for the foreign market.[40]

These considerations apply, in particular, to the case of Italian manufacturing, where small firms often engage in incremental innovation and product adaptation.

7. CONCLUDING REMARKS

In this paper, we have used an extremely rich data set on Italian manufacturing firms to investigate the effect of a firm's export status on the likelihood of its introducing product innovations.

We have shown that a statistically significant correlation between a firm's export status and the probability of its introducing product innovations – consistent with learning by exporting – remains even after controlling for many observable firm characteristics that may be responsible for it.

[38] In Section 5, we find a lower effect of export status on process innovativeness of Italian firms, which should be instead greatly affected in case they suffer from a substantial technological gap with respect to foreign firms.

[39] The role of cross-country consumer taste heterogeneity has been highlighted by Dinopoulos (1988) and, more recently, by Bernard et al. (2011) and by Di Comite et al. (2011) in a heterogeneous firms framework where firms choose their product range.

[40] Some insights into the role of location in the product space with respect to innovation induced by buyer–supplier relationships across countries are given by Grossman and Helpman (2005), while Puga and Trefler (2010) highlight how buyer–supplier relationships may also result in different innovation strategies when developed across countries, owing to incomplete information.

This result is also robust to allowing firm's export status to be endogenous using an instrumental variables strategy. Indeed, when we use supply-push and demand-pull instruments based on the firm's distance from potential export markets and these markets' potentials, export status turns out to have a high, and significant, positive effect on product innovation activity. We also report some preliminary evidence that product innovation seems to mediate the positive relationship between process innovation and export status, which would be consistent with exporters mainly introducing new production methods in response to their need to produce new products, an interesting hypothesis which would be worth investigating in future work.

Although our data do not enable us to precisely determine the mechanisms through which export status enhances product innovativeness, after controlling in our analysis for several mediating variables (e.g. firm size, R&D investment), our analysis suggests that a possible source for the 'residual' effects we are capturing may be the interaction between exporters and foreign customers (consumers or firms) and in particular the need of a domestic firm to modify its product when entering and staying in a foreign market.

Our results highlight that firms may differ not only in how they produce, but also in what they produce. Whether and how the characteristics of firms' products meet foreign needs, even between similar countries, may be crucial for enhancing innovation. From a policy perspective, this positive effect of export status on firm-level product innovation has both welfare implications, as a better match with customer needs should be reached through trade integration, and growth implications, since product innovation has positive effects on firms' sales and employment (Hall et al., 2008) and it is at the basis of firms' competitiveness and surviving worldwide competition.

Owing to the nature of our data, which do not allow us to explore these hypotheses further, a deeper understanding of the role of 'demand as information' both at the theoretical and at the empirical level is left for future work.

APPENDIX A1

Description of the Variables

Product Innovation

This is the dependent variable, which takes on the value one if a firm improved substantially its products or introduced new products during 2001–2003 and zero otherwise. Source: SIMF, 9th wave.

Export Status

This is a dummy variable that takes on the value one if a firm exported in 2000 and zero otherwise. Source: SIMF, 8th wave.

Export Distance

This is a sector-specific measure of the distance of a firm from its most likely potential export markets. See Section 4.b for more details. Source: export data from OECD's STAN Bilateral Trade Database, coordinates data from http://www.cepii.fr/anglaisgraph/bdd/distances.htm. Unit of measurement: 100 km.

Market Potential

This is an inverse-distance weighted measure of gross GDP per capita in 1997 evaluated at 2000 US dollars. The measure considers the top 25 export market destinations by industry (2-digit ATECO). Source for gross GDP per capita is the World Bank Development Indicators.

Size

Number of employees in 2000, divided by 100. Source: SIMF, 8th wave.

Graduate Ratio

Fraction of employees with a university degree, 2000. Source: SIMF, 8th wave.

Real Capital Intensity

This is the ratio between the real capital stock and the number of employees in 2000. The nominal capital stock is derived from balance sheet data and is evaluated at the net 'historical cost', that is, the cost originally borne by the firm to buy the goods, reduced by the depreciation measured according to the fiscal law (*Fondo di ammortamento*), which accounts for obsolescence and use of the goods. The real capital stock is obtained using capital stock deflators provided by the Italian National Statistical Institute (cf. Moretti, 2004). All variables are deflated by the appropriate 3-digit production price index (ISTAT). Source: SIMF, 8th wave. Unit of measurement: thousands of year 2000 Euros.

Unit Labour Cost

Unit labour costs in 2000 (and 1998) are computed as the ratio between total real labour cost and real production. Real production is 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 by the appropriate 3-digit production price index provided by ISTAT. Unit labour costs in 1998 are used as an instrument for export status in 2000. Source: SIMF, 8th wave; 3-digit industry-specific deflators from ISTAT. Unit of measurement: thousands of year 2000 Euros.

Per cent R&D to Introduce New Products

This is the percentage of R&D borne by a firm in 1998–2000 to introduce new products. Source: SIMF, 8th wave.

R&D Intensity of Employment

This is the number of R&D employees divided by total firm employment in 2000. Source: SIMF, 8th wave.

Invested in ICT

This is a dummy variable that takes on the value one if a firm invested in ICT during 1998–2000 and zero otherwise. Source: SIMF, 8th wave.

Variation in Real Capital Stock

This is the amount of real firm investment in 1998–2000. Nominal investments are deflated by the appropriate 3-digit production price index provided by ISTAT. Source: SIMF, 8th wave. Unit of measurement: hundred thousands of year 2000 Euros.

FDI Flows

This is a dummy variable that takes on the value one if a firm carried out FDI during 1998–2000 and zero otherwise. Source: SIMF, 8th wave.

Bought Patents Abroad

This is a dummy variable that takes on the value one if a firm bought patents abroad during 1998–2000 and zero otherwise. Source: SIMF, 8th wave.

Foreign Ownership

This is a dummy variable that takes on the value one if a firm was foreign-owned in 1998–2000 and zero otherwise. Source: SIMF, 8th wave.

Border Province

This is a dummy variable that takes on the value one if a firm is located in a province bordering a foreign country and zero otherwise. Source: SIMF, 8th wave.

Decentralised Management

This is the ratio between the number of entrepreneurs, managers and cadres, divided by the total number of employees in 2000. Source: SIMF, 8th wave.

Return on Investment

ROI index in 2000. Source: SIMF, 8th wave.

Real Cost Per Worker

This is the total labour cost divided by the number of employees (real average wages) in 2000. Nominal labour costs are deflated by the appropriate 3-digit production price index provided by ISTAT. Source: our computation on SIMF, 8th wave. Unit of measurement: thousands of year 2000 Euros.

Bank Branches Per 10,000 Population

Bank branches per 10,000 population in 1997. Source: kindly provided by Alessandrini, Presbitero, and Zazzaro (Alessandrini et al., 2008).

Banks' Functional Distance

It is the average distance between a bank's headquarters and its local branches at the provincial level in 1997. Source: kindly provided by Alessandrini, Presbitero and Zazzaro (Alessandrini et al., 2008). Unit of measurement: 100 km.

R&D Consortium

This is a dummy that takes on the value one if a firm participated in an R&D consortium in 1998–2000 and zero otherwise. Source: SIMF, 8th wave.

Lagged Product (process) Innovation

This is a dummy variable that takes on the value one if a firm introduced product (process) innovations during 1998–2000 and zero otherwise. Source: SIMF, 8th wave.

Process Innovation

This is a dummy variable that takes on the value one if a firm introduced process innovations during 2001–2003 and zero otherwise. Source: SIMF, 9th wave.

APPENDIX A2

Robustness Checks to Alternative Proxies of Innovation

As we said, our measure of product innovativeness and similar measures used in the literature have two main weaknesses: (i) they are subjective measures and (ii) they do not allow for distinguishing between the introduction of new products and the simple improvement of older products.

For this reason, we use some other pieces of information collected in the 9th SIMF wave. Firms that did invest in 2001–2003 were also asked the following question:

What are the objectives of the investiments you made during 2001–2003? Please, specify the degree of importance (1 high, 2 medium, 3 high)
C1.4.1 Quality improvement of existing products
C1.4.2 Increase in the production of existing products
C1.4.3 Production of new products
C1.4.4 Lower environmental impact…

For each objective, we build an indicator that equals one if the firm ranked it as 'high' and zero otherwise.

These indicators were then used to estimate linear probability models with OLS. We used the same specification in column (8) of Table 3. Table A1 reports the results. Row (1) shows no association between a firm's export status and investments made to improve existing products. By contrast, row (2) shows that exporters in 2000 are about 8 percentage points more likely to invest for producing new products between 2001 and 2003. Rows (3 and 4) report a kind of a 'falsification' check, to see whether exporting firms are likely to answer positively questions defining other 'virtuous' behaviours (such as increasing production or investing to reduce the environmental impact of production), which however does not seem to be the case.

The pattern of results in this section seems to show that (i) the answers to the export status and the product innovation questions are characterised by a statistically significant, positive and large association that is not found between export status and other kinds of firm behaviour, suggesting that the association is unlikely to be driven by the subjective nature of the innovation indicator

TABLE A1
Robustness Checks (OLS)

Dependent variables	*Mean*	*Coef.*	*SE*	*No. obs.*	R^2
1. Invested for improving old products in 2001–2003	0.608	0.041	(0.032)	1343	0.056
2. Invested for new products in 2001–2003	0.256	0.079	(0.026)	1302	0.103
'Falsification' check					
3. Invested for increasing production of old products in 2001–2003	0.438	0.012	(0.032)	1337	0.060
4. Invested for reducing environmental impact in 2001–2003	0.209	0.012	(0.027)	1289	0.062

Notes:
(i) The dependent variables are dichotomous indicators that equal one in case a specific investment objective was ranked of high (rather than of medium or low) importance. The columns 'mean' show the mean of the dependent variable in the estimation sample, and 'Coef.' and 'SE' the coefficient on firm export status (in 2000) and its heteroskedasticity robust standard error, respectively. All regressions also include the covariates of Model (8) in Table 3 and are estimated on firms which made investments in 2001–2003 and for which the dependent variable is nonmissing.
(ii) *, **, *** statistically significant at the 10, 5 and 1 per cent level, respectively.

used and (ii) export status leads to the introduction of new products, rather than to a simple improvement of existing products.

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