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ARE EXPORTERS MORE LIKELY TO INTRODUCE PRODUCT INNOVATIONS?*

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Abstract

We analyze the relationship between a firm's export status and its product innovation activity by using a rich firm-level survey on Italian manufacturing. We find that the positive association between exporting and product innovativeness is robust to controlling for many sources of firm's observable heterogeneity. Use of an instrumental variables strategy allows us to conclude that this association can be qualified as a causal relation: firm's export status induces product innovations (*learning by exporting*). This effect emerges over and above the correlation accounted for by some of the main channels of influence commonly emphasized by the existing literature. In the light of this evidence, we discuss the sources from which the residual effect of exporting on product innovation that we observe may originate.

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

The introduction of new or better products is recognized as the ultimate force driving a country's process of economic development, from the classics of economic thought up to the recent endogenous growth literature (Grossman and Helpman, 1991; Aghion and Howitt, 1998). New or better products can be used either to implement more efficient technologies in production, enhancing productivity, or to satisfy new or more sophisticated needs, overcoming demand saturation (Aoki and Yoshikawa, 2002). A large part of product innovation does not consist in radical 'inventions', but in minor incremental innovations carried out by firms in their day by day life (Rosenberg, 1982; Hippel, 1988). Recent empirical evidence shows 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). At the same time, the higher innovativeness of firms that export can be considered as a very strong empirical regularity (see Section 2). In spite of this, the direction of the relationship between exporting and product innovativeness is far from being completely understood. Indeed, exporting might induce innovation, innovation might induce exporting or both activities may be determined by other firm characteristics.

Although we do not rule out the existence of the other not mutually exclusive explanations for the positive correlation between exporting and innovation, in our paper we mainly aim to shed light on the first channel by analyzing whether firm's engagement in foreign markets leads to higher product innovativeness.

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

This literature distinguishes between technology-push factors, highlighting 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 in terms of flow of ideas generated by information on customers' needs.¹ 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 equilibrium framework where trade liberalization 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;² 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.

Finally, it is worth mentioning another activity that closely relates to innovation, that is to say imitation, by which firms are (often) engaged in copying the products already developed by competitors (Segerstrom, 1991).³ In this case, exporters may imitate foreign competitors.

Despite the fact that many of these channels operate at the firm level, most of the existing empirical research assesses the effect of trade on innovation at the industry or the country level.⁴ Research on the effect of exporting on product innovation at the firm level is very scant, the bulk of the contributions investigating whether innovation induces export or whether ex-ante more innovative firms self-select into international markets.

In this paper we explore the relationship between export activities and a firm's propensity to introduce new or better products, in order to understand whether the positive association between the two activities can be qualified as causal and going from exporting towards product innovation (*learning by exporting*). We also discuss the potential sources and *pathways* of this effect.

Assessing the existence and magnitude of *learning by exporting* and the pathways through which it operates is important to develop policy recommendations. For instance, if 'better' and more innovative firms self-select

¹For a systematic review related to innovation in manufacturing, see Becheikh et al. (2006); see also Section 5 below.

²According to the two basic Schumpeterian hypotheses, foreign market may represent: 1) 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; 2) an increase in the product market competitive pressure, that might force firms to innovate in order to survive.

³Due to the nature of firm-level survey data, it is not always possible to make a clear distinction between innovation and imitation at the empirical level unless patent applications or accreditation are used as dependent variables.

⁴Keller (2004), Breschi et al. (2005).

into the international markets and there is no *learning by exporting*, then a reduction in trade barriers is not useful to increase the innovation propensity of *all existing* firms in a country. Trade openness would in this case have an impact on the average performance of a sector or a country through the survival of ‘fittest’ firms. On the contrary, if a positive effect of export on innovation is at work, reducing barriers to trade will also improve the innovation performance of the existing firms which decide to export, raising their likelihood to survive the international competition.

We think that considering product innovation to assess *learning by exporting* is useful for several reasons. First, as previously stated, product innovation is relevant per se since gives different information with respect to alternative indicators of firm efficiency such as process innovation or productivity.⁵ 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. This motivates also the specific interest in Italy. Many surveys show that although few firms do R&D investments, many of them introduce product innovations. Hence, using a subjective indicator of product innovation can 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).

We study the effect of exporting on product innovation using a rich firm-level database on manufacturing, the Survey of Italian Manufacturing Firms (*Indagine sulle Imprese Manifatturiere*, SIMF hereafter), which provides a wealth of information both on the inputs and the outputs of innovation and internationalization activities.⁶ We first check for the robustness of the positive relationship between export and product innovation by using ordinary least squares (OLS) on the (rich) data we have. Secondly, we make an attempt to address the issue of the potential firm *self-selection* according to unobservable characteristics into foreign markets and the consequent endogeneity of firm export status with respect to product innovativeness – recently emphasized by the New-New Trade Theory literature – using an instrumental variables (IVs) strategy. Last but not least, we discuss the

⁵Moreover, the use of 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, since price and quantity data are not separately available.

⁶For some related literature using the same dataset 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 that will be carried on seven European countries within the framework of the EFIGE project, a large scale project funded by the EU commission under the FP7 programme.

possible sources and pathways of the positive effect of exporting on product innovation.

Our empirical analysis shows three 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 potential endogeneity of firm’s export status is tackled using an IVs strategy, exporting 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 exporting remains even after controlling for many covariates capturing a higher ‘formal’ investment for innovation and the effect of scale, and for other variables capturing firm’s absorptive capacity.

Although our data do not allow us to directly identify the sources of the estimated effect, our analysis leads us to exclude that it is explained by the main 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, we advance the hypothesis that one possible source of the *learning by exporting* that we find may be the cross-country heterogeneity either in consumers’ tastes or in firms’ needs for specific inputs. As a matter of fact, what a firm produces in the domestic market may not necessarily meet the foreign buyers’ needs and a firm may be forced to modify or improve the product in order to find a niche in the 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 are too expensive or difficult to collect otherwise.

Our results are nonetheless consistent with the existing literature finding an important role of formal R&D activities and firm productivity – proxied by unit labour costs – in explaining both firm export status and product innovativeness.

The structure of the 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 aiming at estimating the causal effect of firm’s export status on product innovativeness and Section 5 discusses the potential causal pathways of this link and of the effect we estimate. Section 6 summarizes the main findings and concludes.

2 Firm-level empirical evidence on export and innovation

In this paper we focus on the most common internationalization mode (exporting) and on a direct measure of product innovation, that is a firm's likelihood of *introducing a new or an improved product*.

Our analysis should be seen as complementing other studies focusing on different measures of innovation such as R&D, process innovation or productivity.

The positive relationship between firms' innovation and export activities may be due to a two-way causal link or to a *self-selection* mechanism. In short, exports may induce innovation, innovation may spur exports, or a third unobservable firm characteristic (e.g. firm productivity) may make some firms self-select into both activities.

The positive effect of innovation on export activities has been widely investigated at the empirical level, by using different measures of innovation. Several contributions – at the macro, the industry and, more recently, the firm level – reach consensus on the positive effect of innovation, in particular R&D investment, on export activity.⁷

The *self-selection* mechanism recently stressed by the New-New Trade Theory has fed a wealth of empirical studies focusing on the relationship between internationalization and firm performance using firm-level data.⁸

A wide consensus has been reached by the empirical research that more productive/innovative firms self-select into international markets, but many contributions using rigorous empirical strategies have been able to also identify positive causal effects of export activity on firm's productivity (for a review see [Wagner, 2007](#); [Greenaway and Kneller, 2007](#)). More recently, some contributions ([Costantini and Melitz, 2008](#); [Iacovone and Javorcik, 2010](#)) have argued that both the innovation performance and the export activity may represent a consequence of previous firms' decisions on R&D investment (an hypothesis labeled as *anticipation effect*, *conscious self-selection* or *learning to export*).

⁷Among the others, see [Basile \(2001\)](#), [Lachenmaier and Woessmann \(2006\)](#) and [Cassiman and Martinez-Ros \(2007\)](#).

⁸The 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 (and perhaps innovative) enough to bear the sunk costs of entry ([Melitz, 2003](#); [Hallak and Sivadasan, 2007](#)). Nevertheless, 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 higher income countries (see, for instance [Verhoogen, 2008](#); [Crinò and Epifani, 2009](#)). Some others look at multiproduct firms (see, for instance [Bernard et al., 2009, 2010](#)). Here, self-selection is not only across firms but also within firms across product lines. Trade liberalization increases productivity at the firm level by inducing firms' specialization in the product lines in which they are more efficient.

As for the literature related to the causal effect of exporting on product innovation, we are aware of only few studies. A recent paper by [Liu and Buck \(2007\)](#) considers 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 by using a panel of sub-sector level data for Chinese high-tech industries, and new products are defined as either novel or improved products. The authors show a positive and significant effect of all the interactions between a measure of absorptive capacity and the three internationalization modes on product innovation; only exporting remains positive and significant taken by itself. It is worth noting that while domestic R&D loses statistical significance when the other variables are introduced, firm size remains one of the most relevant determinants of innovation in all specifications. [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 volumes on innovation performance, conditional on the firm’s size, R&D expenditure and advertising intensity. In particular, the increase in product innovation takes place soon after exporting. In contrast to the previously mentioned contribution, firm size is never significant, while R&D expenditure and previous innovation have a positive and a negative impact on innovation, respectively. Last but not least, [Fafchamps et al. \(2008\)](#) use a panel of Moroccan manufacturers and find that product innovativeness is positively related to the length of export 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 garment, textile, and leather – to design products that appeal to foreign consumers.⁹

From the above mentioned contributions, it emerges that exporting is an important channel of product innovation, even when controlling for R&D expenditure and independently of a firm’s absorptive capacity.¹⁰ The channels through which exports positively impact on innovation emphasized by these contributions are: the information exchange with foreign markets,

⁹Two other contributions provide evidence of the existence of a positive association between export and innovation without aiming at identifying causal effects: [Castellani and Zanfei \(2007\)](#) and [Gorodnichenko et al. \(2008\)](#), which also consider other channels of technological transfer.

¹⁰For the sake of completeness, there are also studies finding different results. For instance, [Baldwin and Gu \(2004\)](#) find evidence of self-selection in both product and process innovation among Canadian exporters but *learning by exporting* in productivity. As the same authors recognize, the difference in results across countries is very likely to stem from the specificities of their industries (e.g., product specialization, technology).

through personal contacts with buyers and export intermediaries;¹¹ the pressure of foreign competition. The other traditional channels of international spillovers (information exchange with MNEs firms and knowledge embodied in imported technology) seem to be relevant especially when absorptive capacity is considered. As for the role of R&D expenditure, it is generally confirmed to be positive and relevant in explaining innovation, while the evidence on firm size is more mixed.

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 hi-tech industries only but extends to the whole Manufacturing. This is important as in hi-tech sectors most innovation is likely to be generated by 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 specialization in low skill productions ([Faini et al., 1999](#)). Our analysis adds to the very scant literature using firm-level data. We consider a different country from [Salomon and Shaver \(2005\)](#) and [Fafchamps et al. \(2008\)](#), which is important as the effect of exporting on innovativeness may depend on the specific features – structure and specialization – of an industry.¹² Although, unlike these two studies, we do not have panel data, we dispose of a richer set of controls in our data that enables us to shed light on the potential pathways which might explain the effect of export that we estimate, or at least to exclude some.

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 by Capitalia).

The survey collects information on a sample of manufacturing firms with 11-500 employees and on all firms with more than 500 employees. The SIMF has been repeated over time at three-year intervals and in each wave a part of the sample is fixed while the other part is completely renewed every time (see [Capitalia, 2002](#), p. 39). This helps analyze both variations over time for the firms observed in different waves (panel section) and the structural changes of the Italian economy, for the part of the sample varying in each wave. Like in many other surveys used in the empirical literature,¹³ also SIMF is biased against micro-firms and cannot be considered as representative of the whole Italian Manufacturing sector, but only of the target firm population.

The data set gathers a wealth of information on: balance sheet data in-

¹¹See also [Crespi et al. \(2008\)](#)

¹²See, for instance, the explanation that [Baldwin and Gu \(2004\)](#) give for the existence of *learning by exporting* effects in productivity for Canadian but not for U.S. manufacturers.

¹³See, for instance, [Bernard and Jensen \(2004\)](#), [Becker and Egger \(2009\)](#).

tegrated 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 area); information on financial structure and strategies. In order 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 different reasons, such as non-response, cessation of activity, drop of firm size under 11 employees or change of sector. Moreover, due to the rotating structure of the panel, using more than two consecutive waves would greatly reduce the number of firms appearing in the sample, exacerbating potential sample 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 8th-9th wave panel. Table 1 compares means and standard deviations for these variables. The 1998-2003 panel appears to be fairly representative of the 1998-2000 cross-section under several dimensions, although the firms in the panel are slightly larger and more R&D intensive, both factors which might positively affect product innovation.

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.¹⁴ The dependent variable INN takes on value one in case of positive answer and zero otherwise.¹⁵ 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

¹⁴In 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 exporting on the *number of products* produced by firms (cf. Bernard et al., 2010).

¹⁵It 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 export data. A 10th wave of SIMF was released for the period 2004-2007 but because of a change of questionnaire and severe non-response, the linkage between the 9th and the 10th waves is problematic and we prefer to use the 8th-9th waves panel. Considering only firm export status we are likely to estimate an ‘average effect’ over the ranges of export intensity typically observed among Italian exporters.

and not only in the product ‘image’ (e.g., design or re-packaging).¹⁶

Our main independent variable of interest is exporting in 2000 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 on value one in case of positive answer and zero otherwise.

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

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

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 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’s characteristics, the positive correlation between export status and product innovativeness should disappear. This is what we will assess in Section 4.1, by including several firm’s characteristics that are likely to affect both export and innovation activities in a linear regression estimated using ordinary least squares,

¹⁶The direct measure of product innovation on which is based this analysis suffers of the subjectivity of the answer and is an ‘unqualified’ measure of innovation. It is worth noting that also patents as indirect measures of innovation have limitations, in that they measure inventions rather than innovation and, on the other side, not all the innovations are patented; the other direct measures of innovation used in the literature, innovation count, has the risk of privileging major/radical innovations with respect to minor/incremental ones and may depend in turn on the subjectivity of the panel of experts evaluating and counting the innovations (Becheikh et al., 2006). The firm-based survey approach of collecting information on innovation is used by several regional and international institutions such as Eurostat. In particular, the question in the survey used in our analysis corresponds to the one 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).

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’s characteristics responsible for both outcomes. In this latter case, we have an endogeneity problem: firm’s unobservables may affect both exporting 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 towards product innovation (shown in the figure with the bold line), is using an IVs strategy. This consists of finding an exogenous (to the individual firm) source of variation in firm’s export status. In Section 4.2 we will mainly use as a source of identification demand-pull factors, related to the *countrywide* patterns of Italian exports by industry and to features of the countries to which these exports are directed. This will also help to solve the potential reverse causality problem shown with the dashed arrows in Figure 1: successful innovators are more likely to export.

4.1 Ordinary least squares

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

$$\text{INN} = a_0 + a_1\text{EXP} + a_2\mathbf{X} + u \quad (1)$$

where \mathbf{X} is a vector of firm’s characteristics that might affect both innovation and export and u is an error term.¹⁷

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 this correlation.

The OLS results are shown in Table 3, which reports specifications progressively adding covariates.

In Model (1), which only includes export status, the estimated coefficient of exporting on the likelihood of introducing product innovations is 0.27 and highly statistically significant.

Some characteristics that may be associated with both a firm’s export status and product innovation are the industry (2-digit ATECO sector¹⁸) in which a firm operates and its geographical location – region, i.e. NUTS 2 –

¹⁷As known, the LPM has both advantages and disadvantages with respect to binary response models, such as probit or logit models. The main advantage is that the LPM does not require assuming a specific distributional form for the error term u (e.g., normality in case of the probit model), while the main disadvantage is that the predicted values are not constrained to be in the unit interval.

¹⁸ATECO stands for *Classificazione delle attività economiche*, that is an Italian classification of economic activities (i.e. industries) equivalent to NACE European classification.

which are then included in the regression. Model (2) shows a reduction in the effect of export status, which falls to 0.21. Exclusion Wald tests show that industry is a much better predictor of 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 firm’s geographical location in the specifications that follow, in order 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, a dummy for group membership, dummies for spin-offs and mergers or acquisitions, firm size (number of employees), capital intensity and unit labor costs. The dummy for group membership and the one for mergers and acquisitions are positively and significantly (at the 5% statistical level) associated with product innovation, while unit labor costs are strongly negatively associated with firm’s innovativeness.¹⁹ Physical capital intensity is negatively associated with product innovations, and the coefficient is statistically significant at the 10% level. The coefficient on export status falls to 0.18.

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. 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 0.15, suggesting that part of the correlation between export status and product innovation might be 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, which is likely to affect both product innovation and export, reduces the innovation effect of export.

Model (5) includes controls for other forms of potential international spillovers, in addition to those running through trade, such as acquisition of patents from abroad, a dummy for foreign ownership, a dummy for being located in a province bordering a foreign country and flows of FDIs. The last covariate only turns out to be positively associated with product innovation, but the coefficient on export is only slightly affected. This result is not unexpected as in our data very few firms perform FDI flows (less than 2%

¹⁹Firm size is not significant, but scale effects are likely to be captured by lower unit labour costs.

in our estimation sample) while many firms export (about 68%), and the correlation between the two activities is not large.²⁰

Model (6) includes further controls for managerial quality or decentralization, proxied by the return on investment index (ROI) and by the ratio of entrepreneurs, managers and cadres over total number of employees, respectively. Both variables are not significant and the coefficient on export status falls only slightly to 0.14.

Model (7) introduces two proxies of firm's absorptive capacity: average labor costs and the percentage of graduates over total firm's labor force. The latter turns out to be significantly (at the 10% statistical level) and positively associated with firm's product innovativeness. The coefficient on export is not affected.

Model (8) controls for some proxies of the presence of firm's financial constraints, proxied by 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).²¹ Both variables turn out to be statistically insignificant, and the coefficient on export does not change.²²

Although model (8) represents our preferred specification, we also estimated a model including lagged product innovation status as an additional control variable, Model (9).²³ This might be important in order to capture the potential dynamic structure of the product innovation process. Indeed, it might be the case that firms who 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 innovation* (during 1998-2000). However, our results show that even after controlling for past product innovation the coefficient on export is only marginally affected, falling by 0.008, and remains highly statistically significant. Lagged product innovation is positively and significantly correlated with current product innovation. These estimates suggest, overall,

²⁰We 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. Given that we only have imperfect proxies of FDI stocks, and especially of delocalization 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 perform FDIs, and firms with more the 25 employees, and the effect of export status turned out to be very similar in the two subsamples.

²¹See [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.

²²This finding is qualitatively consistent with [Benfratello et al. \(2008\)](#) that 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.

²³This variable, like export status, may be endogenous, but here, since we estimate this specification only as a robustness check, we neglect this potential problem by using OLS.

that past export status is at least as important as past product innovation for the probability of current product innovation.²⁴

Hence, 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 which might generate a spurious correlation. Firms that exported in 2000 are *ceteris paribus* about 14 percent points more likely to introduce product innovations in 2001-2003 than those that did not export, in our preferred specification (8).²⁵ 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 of potential *endogeneity* of export status using an IVs strategy.

4.2 Instrumental variables

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

From gravity models we borrow the idea that a firm’s export status should be strongly negatively correlated with the distance between its geographical location and potential destination countries for its products (as transportation costs generally increase with distance), which represents one of the most robust empirical findings in international economics (Leamer and Levinsohn, 1995; Disdier and Head, 2008). In particular, we have information on the province (NUTS 3) in which a firm is located.²⁶ Potential destination countries for a firm’s products were identified by considering for

²⁴We also estimated a specification adding lagged process innovation as a covariate. One possible criticism to our results is, indeed, that past adoption of process innovations induced by firm’s internationalization might affect future product innovations. In that specification the coefficient on export status is 0.14, significant at the 1% statistical level, while the coefficient on past process innovation is 0.06, significant at the 5% level. Hence, the effects of past export status and process innovations on current product innovations appear to be independent. Some recent literature is stressing the role of import on process and product innovation (Liu and Buck, 2007; Gorodnichenko et al., 2008; Esteve-Perez and Rodriguez, 2009), but unfortunately we do not have data on it. Thus, we built a proxy for import which is a dummy that takes on 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 remains 0.14, statistically significant at the 1% level, while the coefficient on the proxy for import is 0.10, significant at the 5% level.

²⁵We also estimated model (8) using a probit specification. The average marginal effect computed at the sample mean turns out to be 0.16, statistically significant at the 1% level. We prefer (8) over (9) since the latter includes the lagged dependent variable, which is very likely to be endogenous and for which we do not have good instruments.

²⁶In Italy, in the period we study, there were 103 provinces.

each 2-digit ATECO sector the first 25 countries in terms of export value to which Italy exported in 1997.²⁷ Individual countries' weights were determined by dividing the export value to a specific country by the total value of exports to all top 25 countries by sector.²⁸ This implies that both destination countries and country weights are different across sectors. This procedure enables us to compute a *sector-specific measure of firm's average distance from export markets*, that is a measure of distance that varies across sectors and that we call 'export distance', EXPDIST. Formally, EXPDIST was computed as follows:

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

where d_{pj} is the great circle distance between province p and country j and $w_{ij} = \frac{\text{EXPORT}_{ij}}{\sum_{j=1}^{25} \text{EXPORT}_{ij}}$ is the weight of country j on the total exports of sector i (on the first 25 destination countries for sector i).²⁹

Two firms in the same province have different 'export distances' if they are in different sectors while two firms in the same sector and in different provinces have different measures of 'export distance', due to their different geographical locations. In order for the instrument to be valid, it is necessary that EXPDIST is not capturing mainly sector or geographical unobservables that also directly affect product innovation. As for the second possibility, our previous OLS result of the insignificance of administrative regions on product innovation makes us rather confident that it should not be the case. However, we control in both stages of IVs for both sector fixed effects and region fixed effects, and for the firm being located in a foreign-border province. The dummy for foreign-border province should capture the fact that firms located in these provinces might be more likely both to be influenced by knowledge spillovers from foreign firms and to export

²⁷We do not use a finer disaggregation of ATECO mainly for two reasons: 1) coding errors increase when considering finer disaggregations; 2) exports are generally not available for all sectors/countries pairs when considering finer disaggregations. We consider the first top 25 export destinations in analogy to [Bernard and Jensen \(2004\)](#).

²⁸Data on export were taken from the OECD's STAN Bilateral Trade Database. Export weights refer to 1997 so as they are predetermined with respect to the period under study (1998-2003).

²⁹Great circle distances d_{pj} were computed using latitude and longitude of Italian provinces and foreign countries' capitals and the spherical law of cosines. The coordinates for countries' capitals were taken from the website <http://www.cepii.fr/anglaisgraph/bdd/distances.htm>. Great circle distances between two points can be computed converting latitude and longitudes of the two points p (province) and j (country) from decimal degrees into radians and applying the following formula: $d_{pj} = 6,371.01 \cdot \arccos(\sin \phi_p \sin \phi_j + \cos \phi_p \cos \phi_j \cos(\lambda_p - \lambda_j))$, where ϕ_p and ϕ_j , and λ_p and λ_j are latitudes and longitudes in radians of the two points and 6,371.01 Km is the average radius for a spherical approximation of the Earth.

to neighboring countries. In any case, in the computation of ‘export distance’ are only considered the main *destination countries of Italian exports by sector*, which are weighed by the fraction of exports. The main source of identification for the effect of EXPDIST on export, that is the variance that we are exploiting, once we control for region and sector fixed effects comes from differences in the first 25 export destination countries and/or their relative weights across different ATECO sectors. In this sense, our variable is much more specific than a simple interaction between province and sector fixed effects, and should be highly correlated with export status, capturing the combined effect of transportation costs and Italian sectoral comparative advantages on firms’ export status, while being loosely correlated or uncorrelated with foreign knowledge spillovers taking place *independently of export*. Indeed, although this is far from being a formal test, when included in the most complete LPM specification estimated with OLS of the product innovation equation, EXPDIST is not statistically significant at the 10% level. This instrument is similar to the ones commonly used in labor economics, e.g. when college distance (or proximity) is used to estimate the effect of education on wages or other outcome variables (see, for instance, [Card, 1993](#); [Currie and Moretti, 2003](#)). Like in those applications, the main assumption for our instrument to be valid is that geographic location - in our analysis firm location - is exogenous with respect to the outcome variable, product innovation activity in our case. A possible criticism is that firm’s location could be endogenous, that is a firm might choose a specific location since it offers a better environment for innovation. However, this criticism does not appear to be particularly relevant for the Italian case given the very low geographic mobility of entrepreneurs. [Michelacci and Silva \(2007\)](#), for instance, using the Bank of Italy’s Survey of Household Income and Wealth (SHIW) data for 1991-1995 show that in Italy about 79% of entrepreneurs established firms in the same province where they were born (‘local firms’). If individuals mainly create firms where they were born, there does not seem to be much space for strategic location behaviour, in terms of search of the better innovation or exporting environments. The authors also show that ‘local firms’ are generally larger, have a higher value and are more capital intensive, which suggests that firms established by non-local entrepreneurs (movers) are not necessarily better (e.g., more innovative).

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

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

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 dis-

tance weighed per capita GDP in 1997 evaluated at 2000 U.S. dollars that is summed across the first 25 destination countries for exports of sector i , obtained as described above for EXPDIST. 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. As we use an overidentified model (see below), we will be able to estimate the instruments’ validity. 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, i.e. it should be exogenous with respect to product innovation at the firm level. Also in this case, since GDPs are weighed by the inverse of geographical distances, the identifying assumption is that firm’s location is exogenous with respect to product innovation.

The third instrument that we propose is lagged unit labor cost, in 1998. This instrument should be valid, since after controlling for unit labor cost in 2000 in the innovation equation, it should not have any additional effect on product innovations between 2001 and 2003. At the same time it may be relevant, since high unit labor costs in 1998 are likely to negatively affect a firm’s export status in 2000.

We will use all three instruments, i.e. an over-identified model, in order to test their validity.

The top part of the Table 4 reports the first stage of the instrumental variables - linear probability model (IVs-LPM), and the bottom part the second stage. Although the Partial R-squared for the excluded instruments is quite satisfactory, 1.3%, the joint F-test is well below the 10 value which represents the rule of thumb suggested by [Staiger and Stock \(1997\)](#) to detect a potential weak instrument problem. Hence, our instruments may be weak and produce an imprecise estimate of the effect of export status on product innovation. Indeed, the coefficient on export status becomes statistically significant only at the 10%, and is much less precisely estimated than with OLS, the standard error rising from 0.027 in model (8) of Table 3 to 0.27 when IVs are used. The Hansen-J statistic shows that the joint null hypothesis that the instruments are valid – that is that they are uncorrelated with the error term and that the excluded instruments are correctly excluded from the estimated equation – cannot be rejected in our specification.³⁰

³⁰We also estimated models using only one instrument at the time, since in the presence of weak instruments the size of the IVs bias is increasing in the number of instruments ([Hahn and Hausman, 2002](#)), but we obtained very similar results. Although in the table we only report results from two-stage least squares, all models were also estimated with limited information maximum likelihood – which is less biased in the presence of weak instruments – without any appreciable improvement in precision. The full set of IVs

From a qualitative point of view IVs results are similar to the OLS results. We tend to interpret the difference in magnitude between OLS and IVs estimates as the result of a likely weak instrument problem. The endogeneity test suggests that the null hypothesis that export status can be treated as exogenous cannot be rejected at the 10% statistical level. We interpret this as evidence that after controlling for a wide range of observable characteristics, the problem of endogeneity of export status, if any, should not be severe, that is export status should be only loosely correlated or uncorrelated with the error term in the product innovation equation and that OLS estimates are unlikely to suffer from a large bias.

In spite of this, we think that it is important to also assess the robustness of our IVs estimates. There are a number of reasons why our IVs strategy could fail. Both EXPDIST and MKTPOT use geographical information on firm's location and assume that it is exogenous. Although, we already said that firm's and entrepreneur's geographical mobility is in general rather limited in Italy, we cannot completely rule out the possibility that some firms might have chosen their locations according to the expected benefits for their innovation activity. We think that firms that are more likely to behave strategically are larger (non-family) firms that have less tight connections with a specific territory. For this reason, we think that it could be important to see how our results change when the analysis is limited to relatively smaller firms, whose location is more likely to be exogenous.

A second potential issue that might affect the EXPDIST and MKTPOT instruments, is that the presence of a specific country among the first 25 destinations by ATECO sector and its weight (only for EXPDIST) may be affected by the (past) export activity of firms in our sample, especially if they are large. In this regard, we stress that weights are computed using pre-determined (1997) data and also in the worse case scenario, in which both destinations and weights are affected by firms in our sample, using this instrument would be similar to using lagged firm's export status as an instrument.³¹ Also in this case, a robustness check is to replicate the IVs estimation for relatively small firms. Indeed, the likelihood that export destination countries and/or their weights at the national level are importantly affected by single firms in our sample is lower for smaller firms.

Hence, column (2) of Table 4 reports the estimates for the sample of firms with less than 50 employees. The results are not qualitatively or quantitatively different from those in the first column.

As a further robustness check for the IVs estimates, in column (3) we report the estimates in the sample of firms that were established in 1990 or before. These firms chosen their location more than 10 years before the

estimates is available upon request.

³¹Firm's lagged export status is not directly used as an instrument since it would require using another wave, the 7th, greatly reducing the sample size.

year which the innovation outcome refers to, and it could be argued that the assumption of exogenous location is very likely to hold in this subsample. The results do not change.

We made a number of other robustness checks that are not reported in the table.³² First, we re-estimated the IVs-LPM model in column (1) using an IVs-probit specification, in which the dependent variable is treated as dichotomic and the independent variable as it were continuous. This model is more restrictive than the IVs-LPM as it imposes joint normality between the error terms in the export and the product innovation equation, and can be estimated with maximum likelihood. The estimated average marginal effect of export status on product innovation evaluated at the sample mean was 0.46, statistically significant at the 1%. The p-value for the Wald test of the null hypothesis of exogeneity of export status, that is that the correlation between the error terms in the product innovation and the export status equations is null, was 0.12. Finally, we re-estimated the model using a sequential probit specification in which both export status and product innovation are treated as dichotomic, which was estimated using maximum likelihood assuming joint normality.³³ In this case the coefficient on export status was not statistically significant, but the Wald test for null correlation between the two equations (product innovation and export status) could not be rejected (p-value=0.89). When switching to the simple probit, as we already said, the effect of exporting turns out to be significant and similar in magnitude to the LPM's estimate. All these pieces of evidence taken together may be interpreted as the absence of a severe endogeneity problem – conditional on the observables – as far as firm's export status is concerned. Moreover, the qualitative result of a positive effect of exporting on product innovativeness is very robust to changing the modelling strategy.

5 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's efficiency indicator (i.e. unit labour costs), in line with the self-selection mechanism emphasized by the recent empirical literature.³⁴

³²The complete set of results is available upon request from the authors.

³³In this model an endogenous dummy enters a probit equation.

³⁴According to the *learning to export* hypothesis mentioned in the Section 2, firms which plan to export start to increase their innovative effort mainly measured with formal R&D

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 requirements of the market. This second approach looks in turn at the market/demand side in two different ways: a) demand as size of the market or ‘incentive effect’ (Schmookler, 1966; Jovanovic and Rob, 1987; Sutton, 1998); b) 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 (Malerba et al., 2007; Adner and Levinthal, 2001).³⁵

In theory, both *technology push* and *demand pull* factors might explain the higher innovativeness of exporters. This microfoundation of the sources of innovation at the firm level can be mapped to the pathways through which export affects product innovation, generally highlighted by the literature. Export may represent either an opportunity to increase the size of the firm’s market and/or an increase in the level of competition generating incentives for the firm to invest in formal R&D expenditures (combining technology push factors with the incentives from the rise in demand size). Being active in the foreign market may also mean having access to foreign researchers’ knowledge (technology push factor). Last, but not least, cross-country heterogeneity in buyers’ needs (either consumers or firms), due to differences in the stage of development (i.e. income and state of technology) and/or

– but this could also extend to other forms of non-R&D innovation effort – before entering the foreign market. 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. Nevertheless, our opinion is that the two hypotheses are intimately related and not mutually exclusive. The same factors pushing firms which *plan* to enter foreign markets may be at work also *after entering*; firms may acquire a better knowledge of the foreign market and furtherly modify their products. In both cases we tend to interpret the higher rate of innovativeness as the ‘causal effect of exporting’. Indeed, were exporting not allowed, not planned or not performed by firms, we would observe a much lower rate of firm’s product innovation. The crucial point for both ‘learning to export’ and ‘learning by exporting’ being considered as the causal effect of exporting is – in our opinion – the possibility to exclude that the higher innovativeness of firms can be exclusively attributed to their unobservable attributes, such as higher productivity.

³⁵Several 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).

in cultural, ethnic, historical differences, may induce exporters to improve, modify or change their products. This may happen through higher investments in formal research, but also informal exchange of information and interactions with foreign buyers and competitors is likely to be important (demand as information).³⁶

In our empirical specifications we are controlling for many covariates that are likely to mediate the effect of export on innovation in terms of higher ‘formal’ innovative efforts such as investments in R&D, acquisition of foreign patents and acquisition of new capital goods to produce different products. Moreover, we control for firm size and unit labor costs (which are likely to fall with firm’s scale of production). Our results are in line with the past literature showing an important role for 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 exporting, drawing from the literature on multiproduct firms (Bernard et al., 2009), is that exporting 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 less 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 exporting 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 ground 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, due to the characteristics of Italian Manufacturing where small size businesses are prevalent, there are possibly only a few exceptions in which firms have enough human resources to carry out R&D by product line, which we are not able to control for with our data, as the descriptive statistics on R&D intensity shows (Table 2).

As we control for proxies of absorptive capacity (graduate ratio and average labor costs) and internationalization modes other than exporting (FDI flows), which could represent some preferential ways to exchange information with foreign researchers, we tend to exclude that our results are mainly

³⁶See, for instance, the findings in Crespi et al. (2008), which investigates learning-by-exporting using a panel of UK firms. The authors show that past exporting is significantly associated with more learning from customers relative to other sources, such as suppliers, competitors and trade associations. The results in Baldwin and Gu (2004) show in an analysis on Canadian firms that exporters learn from foreign buyers through R&D agreements.

driven by technology-push factors.³⁷

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 minor 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 the effective communication between the potential market and the potential supplier, is at the basis of new products’ development, due to uncertainty and ignorance on 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 Trinidad, 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 as 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 dataset 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 estimate, we may wonder now what does distinguish 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

³⁷The interaction with foreign researchers may be more important for process innovation. The same specification of the LPM in Model (8) (Table 3) using a dichotomic variable for having introduced process innovations in 2001-2003 as the dependent variable was estimated with OLS. The coefficient on export status turns out to be 0.064 (s.e.=0.028), significant at the 5% level, an effect much smaller than the one observed for product innovation. This coefficient is statistically different from the one in the product innovation equation of Model (8) at the 5% level. This should not be considered as a formal test, but were the effect of exporting on product innovativeness mainly originating from the supply-side of export markets, we would expect an effect at least as large on process innovativeness.

to innovate.³⁸ Since the largest part of Italian exports take place with economies characterized by similar levels of income and development,³⁹ we doubt foreign taste for quality or superior technologies of foreign firms – probably more relevant for less developed countries – to be the driving forces of product innovativeness of Italian exporters.⁴⁰

Even among similar countries, nevertheless, there are several, not mutually exclusive pathways through which foreign demand may stimulate exporters' innovative behavior. First of all, heterogeneity in consumer tastes across countries due 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, as shown in [Dinopoulos \(1988\)](#).⁴¹ It is worth noting that an exporter entering a new foreign market has to search for a niche to sell his production, this possibly implying changes in the characteristics of his product, not necessarily to meet diverse foreign needs but possibly to differentiate himself from foreign competitors ([Desmet and Parente, 2008](#)). Heterogeneity in tastes may also generate heterogeneity in foreign firms' technological specificities, 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.⁴²

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

6 Concluding remarks

In this paper we have used an extremely rich dataset on Italian manufacturing firms to investigate the effect of a firm's export status on its likelihood of introducing product innovations. We have shown that a statistically significant correlation between exporting and introducing product innovations – consistent with *learning by exporting* – remains even after controlling

³⁸For a comprehensive view of recent contributions, in particular on product quality and cross-country income differences, see for instance [Baldwin and Harrigan \(2007\)](#).

³⁹Firms in SIMF report in 2000 an average percentage of exports directed to EU-15 of 62.6%, and to US and Canada of 9.3%.

⁴⁰As we said, we find a much lower effect of exporting on process innovativeness, which should be instead greatly affected in case Italian firms suffer a substantial technological gap.

⁴¹The role of cross-countries consumer tastes heterogeneity has also recently been highlighted by [Bernard et al. \(2009\)](#), in an heterogenous firms framework where firms choose their product range.

⁴²Some insights on the role of location in the product space with respect to innovation induced by buyer-supplier relationships across countries are given in [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, due to incomplete information.

for many observable firm characteristics that may produce it. This result is also robust to allowing the export status to be endogenous and using an instrumental variables strategy and instruments based on both foreign demand-pull and supply-push factors.

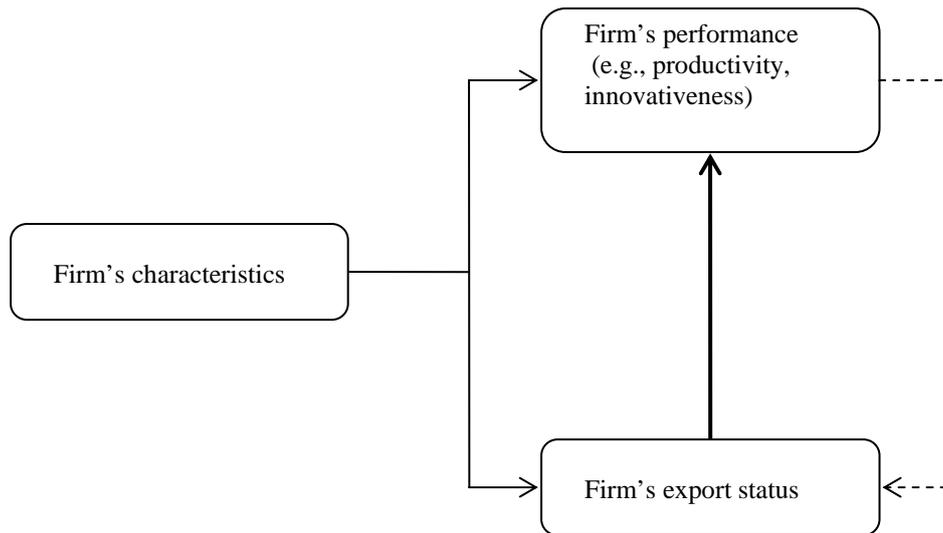
Although our data do not enable us to precisely determine the mechanisms through which exporting enhances product innovativeness, after controlling in our regressions for several mediating variables, our analysis suggests that a possible source for the ‘residual’ effect we are capturing may be the interaction between exporters and foreign customers 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 exporting 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 and it is at the basis of firms’ competitiveness and survival to worldwide competition.

Due 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.

Figures

Figure 1: Sources of association between exporting and firm's performance



Note. The solid arrows on the left side of the figure show a first source of (spurious) correlation between exporting 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 exporting towards product innovation. The dashed arrow shows a genuine causal effect going from firm's performance towards export status (reverse causality).

Tables

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

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

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

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

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

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

Table 3: Probability of introducing product innovations in 2001-2003 (linear probability models estimated with OLS)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Exporter (d)	0.265***	0.206***	0.183***	0.147***	0.145***	0.144***	0.143***	0.144***	0.136***
Firm age			0.001	0.001	0.001	0.001	0.001	0.001	0.001
Group membership (d)			0.071**	0.069**	0.062*	0.062*	0.059*	0.060*	0.053
Spin-offs (d)			-0.017	-0.027	-0.030	-0.029	-0.033	-0.031	-0.024
Mergers or acquisitions (d)			0.097**	0.060	0.060	0.061	0.062	0.065	0.055
Size			0.000	0.000	0.000	0.000	0.000	0.000	0.000
Real capital intensity			-0.423*	-0.452*	-0.449*	-0.422	-0.404	-0.400	-0.379
Unit labor costs			-0.325***	-0.258**	-0.235**	-0.226*	-0.207*	-0.212*	-0.212*
% R&D to introduce new products			0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.001**
R&D intensity on employment			1.274***	1.287***	1.285***	1.224***	1.224***	1.225***	1.175***
R&D consortium (d)			-0.089	-0.102	-0.106	-0.106	-0.110	-0.106	-0.087
Invested in ICT (d)			0.107***	0.105***	0.104***	0.104***	0.103***	0.103***	0.091***
Variation in real capital stock			0.000	0.000	0.000	0.000	0.000	0.000	0.000
FDI flows (d)			0.186***	0.184***	0.184***	0.184***	0.181***	0.180***	0.169**
Bought patents abroad (d)			-0.094	-0.094	-0.094	-0.094	-0.114	-0.110	-0.114
Foreign ownership (d)			0.008	0.006	0.006	0.006	0.006	0.006	-0.009
Border province			0.004	0.004	0.004	0.004	0.006	0.013	0.014
Decentralized management									
Return on investment									
Graduate ratio									
Real cost per worker									
Bank branches per 10,000 pop.									
Banks' functional distance									
Lagged product innovation (d)									
Region fixed effects	no	yes	yes	yes	yes	yes	yes	yes	yes
Industry fixed effects	no	yes	yes	yes	yes	yes	yes	yes	yes
R-squared	0.063	0.109	0.125	0.178	0.181	0.181	0.183	0.184	0.194
No. obs.	1,635	1,635	1,635	1,635	1,635	1,635	1,635	1,635	1,635

* significant at 10% level; ** significant at 5% level; *** significant at 1% (standard errors robust to heteroskedasticity)

Notes. Dummy variables are indicated with (d) after the variable. Only selected variables are reported in the table. For the detailed description of the variables see the Appendix.

Table 4: Probability of introducing product innovations in 2001-2003 (instrumental variables - linear probability models)

	(1) ^(a)	(2) ^(b)	(3) ^(c)
<i>1st stage: Export equation</i>			
<i>Instruments:</i>			
Export distance (100 Km)	-0.014**	-0.013*	-0.015**
Market potential	0.093**	0.134***	0.095**
Unit labour costs (1998)	-0.289**	-0.318**	-0.321**
F-test instruments (p-value)	5.83 (0.00)	6.39 (0.00)	6.19 (0.00)
Partial R ² instruments	0.013	0.017	0.015
<i>2nd stage: Product innovation equation</i>			
Export (d)	0.498*	0.450**	0.434*
Hansen J-statistic (p-value) ^(e)	0.75 (0.69)	^(d)	0.25 (0.88)
Endogeneity test (p-value) ^(f)	2.25 (0.13)	^(d)	1.63 (0.20)
No. obs.	1,635	1,213	1,408

* significant at 10% level; ** significant at 5% level; *** significant at 1% (standard errors clustered at the province \times 2-digit industry level)

Notes. Dummy variables are indicated with (d) after the variable. Only selected variables are reported in the table. The models also include all covariates of Model (8) in Table 3.

^(a) sample includes all firms;

^(b) sample includes only firms with less than 50 employees;

^(c) sample includes only firms established in 1990 or before.

^(d) Stata failed to compute the robust (to clustering) covariance matrix, standard errors are questionable.

^(e) Overidentification test. The joint null hypothesis is that the instruments are valid, i.e., uncorrelated with the error term, and that the excluded instruments are correctly excluded from the estimated equation.

^(f) The IVs models were estimated using the Stata command `ivreg2` and two-stage least squares. The endogeneity test implemented by `ivreg2` 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.

Appendix: (Selected) Variables Description

Product innovation. It is the dependent variable, which takes 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. It is a dummy variable which takes on value one if a firm exported in 2000 and zero otherwise. Source: SIMF, 8th wave.

Export distance. It is a sector specific measure of distance of a firm from its potential export markets. See section 4.2 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. It is an inverse-distance weighed measure of gross GDP per capita in 1997 evaluated at 2000 U.S. 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, 2000. Source: SIMF, 8th wave.

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

Real capital intensity. It 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 cost originally borne by a firm to buy the good reduced by the depreciation measured according to the fiscal law (*Fondo di ammortamento*), which accounts for obsolescence and use of the good. The real capital stock is obtained using capital stock deflators provided by the Italian National Statistical Institute (cf. Moretti, 2004). All variables are deflated with the appropriate 3-digit production price index (ISTAT). Source: SIMF, 8th wave. Unit of measurement: thousands of 2000's euros.

Unit labor costs. Unit labor costs in 2000 (and 1998) are computed as the ratio between total real labor costs 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 with the appropriate 3-digit production price index provided by ISTAT. Unit labor 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 2000's euros.

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

R&D intensity on employment. It is the number of R&D employees over total firm employment in 2000. Source: SIMF, 8th wave.

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

Variation in real capital stock. It is the amount of real firm's investments during 1998-2000. Nominal investments are deflated with the appropriate 3-digit production price index provided by ISTAT. Source: SIMF, 8th wave. Unit of measurement: thousands of 2000's euros.

FDI flows. It is a dummy variable that takes on value one if a firm performed FDI investments during 1998-2000 and zero otherwise. Source: SIMF, 8th wave.

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

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

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

Decentralized management. It is the ratio between entrepreneurs, managers and cadres over 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. It is total labor cost divided by the number of employees (real average wages) in 2000. Nominal labor costs are deflated with the appropriate 3-digit production price index provided by ISTAT. Source: our computation on SIMF, 8th wave. Unit of measurement: thousands of 2000's euros.

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

Banks' functional distance. It is the average distance between a bank's head quarter and local branches at province level. Source: kindly provided by Alessandrini, Presbitero and Zazzaro ([Alessandrini et al., 2008](#)). Unit of measurement: Km.

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

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

Process innovation. It is a dummy variable which takes on value one if a firm introduced process innovations during 2001-2003 and zero otherwise. Source: SIMF, 9th wave.

References

- Adner, R., Levinthal, D., 2001. Demand heterogeneity and technology evolution: Implications for product and process innovation. *Management Science* 47(5), 611–628.
- Aghion, P., Howitt, P., 1998. *Endogenous Growth Theory*, MIT Press.
- Alessandrini, P., Presbitero, A., Zazzaro, A., 2008. Banks, distances and firms' financing constraints. *Review of Finance* 13(2), 261–307.
- Angelini, P., Generale, A., 2008. On the evolution of firm size distribution. *American Economic Review* 98(1), 426–438.
- Aoki, M., Yoshikawa, H., 2002. Demand saturation-creation and economic growth. *Journal of Economic Behavior & Organization* 48(2), 127–154.
- Baldwin, R., Gu, W., 2004. Trade liberalization: Export market participation, productivity growth and innovation. *Oxford Review of Economic Policy* 20(3), 372–392.
- Baldwin, R., Harrigan, J., 2007. Zeros, quality and space: Trade theory and trade evidence. NBER Working Paper No. 13214 .
- Basile, R., 2001. Export behaviour of Italian manufacturing firms over the nineties: The role of innovation. *Research Policy* 30(8), 1185–1201.
- Becheikh, N., Landry, R., Amara, N., 2006. Lessons from innovation empirical studies in the manufacturing sector: a systematic review of the literature from 1993-2003. *Technovation* 26(5-6), 644–664.
- Becker, S., Egger, P. H., 2009. Endogenous product versus process innovation and a firm's propensity to export. *Empirical Economics* online first (doi:10.1007/s00181-009-0322-6).
- Benfratello, L., Schiantarelli, F., Sembenelli, A., 2008. Banks and innovation: Microeconomic evidence on Italian firms. *Journal of Financial Economics* 90(2), 197–217.
- Bernard, A., Redding, S., Schott, P., 2009. Multi-product firms and trade liberalization. paper presented at the 10th Cesifo Venice Summer Institute, 6-11 July 2009 .
- Bernard, A., Redding, S., Schott, P., 2010. Multi-product firms and product switching. *American Economic Review*, forthcoming.
- Bernard, A. B., Jensen, J. B., 2004. Why some firms export. *Review of Economics and Statistics* 86(2), 561–569.

- Breschi, S., Lissoni, F., Montobbio, F., 2005. The geography of knowledge spillovers:, in: *Clusters, Networks and Innovation.*, Oxford University Press.
- Capitalia, 2002. Ottavo rapporto sull'industria italiana e sulla politica industriale, Tech. rep., Capitalia, Rome.
- Card, D., 1993. Using geographic variation in college proximity to estimate the return to schooling. NBER Working Papers n. 4483 .
- Cassiman, B., Martinez-Ros, E., 2007. Product innovation and exports. Evidence from Spanish manufacturing. Unpublished .
- Castellani, D., Zanfei, A., 2007. Internationalisation, innovation and productivity: how do firms differ in Italy? *The World Economy* 30(1), 156–176.
- Costantini, J., Melitz, M., 2008. The dynamics of firm-level adjustment to trade liberalization, in: Helpman, E., Marin, D., Verdier, T. (Eds.), *The Organization of Firms in a Global Economy*, Harvard University Press, forthcoming.
- Crespi, G., Criscuolo, C., Haskel, J., 2008. Productivity, exporting, and the learning-by-exporting hypothesis: direct evidence from UK firms. *Canadian Journal of Economics* 41(2), 619–638.
- Crinò, R., Epifani, P., 2009. Export intensity and productivity. *Development Working Papers* 271, Centro Studi Luca d'Agliano, University of Milano.
- Crépon, B., Duguet, E., Mairesse, J., 1998. Research, innovation, and productivity: An econometric analysis at the firm level. *National Bureau of Economic Research Working Paper* 6696.
- Currie, J., Moretti, E., 2003. Mother's education and the intergenerational transmission of human capital: Evidence from college openings. *Quarterly Journal of Economics* 118(4), 1495–1532.
- Desmet, K., Parente, S., 2008. Bigger is better: Market size, demand elasticity and innovation. IMDEA, Working Paper No. 10. *International Economic Review*, forthcoming.
- Dinopoulos, E., 1988. A formalization of the 'biological' model of trade in similar products. *Journal of International Economics* 25, 95–110.
- Disdier, A.-C., Head, K., 2008. The puzzling persistence of the distance effect on bilateral trade. *Review of Economics and Statistics* 90(1), 37–41.
- Esteve-Perez, S., Rodriguez, D., 2009. The dynamics of trade and innovation: A joint approach. Unpublished .

- Fafchamps, M., El Hamineb, S., Zeufack, A., 2008. Learning to export: Evidence from Moroccan manufacturing. *Journal of African Economies* 17(2), 305–355.
- Faini, R., Falzoni, A. M., Galeotti, M., Helg, R., Turrini, A., 1999. Importing jobs and exporting firms? On the wage and employment implications of Italian trade and foreign direct investment flows. *Giornale degli Economisti* 58(1), 95–135.
- Friedman, J., Gerlowski, D., Silberman, J., 1992. What attracts foreign multinational corporations. *Journal of Regional Science* 32(4), 403–418.
- Gorodnichenko, Y., Svejnar, J., Terrell, K., 2008. Globalization and innovation in emerging markets. IZA DP No. 3299, IZA, Bonn .
- Greenaway, D., Kneller, R., 2007. Industry differences in the effect of export market entry: Learning by exporting? *Review of World Economics* 143(3), 416–432.
- Grossman, G., Helpman, E., 2005. Outsourcing in a global economy. *The Review of Economic Studies* 72(1), 135–159.
- Grossman, G. M., Helpman, E., 1991. *Innovation and Growth in the Global Economy*, MIT Press.
- Hahn, J., Hausman, J., 2002. Notes on bias in estimators for simultaneous equation models. *Economics Letters* 75(2), 238–241.
- Hall, B., Lotti, F., Mairesse, J., 2008. Employment, innovation, and productivity: evidence from Italian microdata. *Industrial and Corporate Change* 17(4), 813–839.
- Hallak, J., Sivadasan, J., 2007. Productivity, quality and exporting behaviour under minimum quality requirements. Unpublished .
- Harris, C., 1954. The market as a factor in the localization of industry in the United States. *Annals of the Association of American Geographers* 44(4), 315–348.
- Hippel, E. V., 1988. *The Sources of Innovation*, Oxford University Press.
- Iacovone, L., Javorcik, B., 2010. Shipping the good tequila out. investment, domestic unit values and entry of multi-product plants into export markets. Unpublished .
- Jovanovic, B., Rob, R., 1987. Demand-driven innovation and spatial competition over time. *Review of Economic Studies* 54(1), 63–72.

- Keller, W., 2004. International technology diffusion. *Journal of Economic Literature* 42(3), 752–782.
- Lachenmaier, S., Woessmann, L., 2006. Does innovation cause exports? Evidence from exogenous innovation impulses and obstacles using German micro data. *Oxford Economic Papers* 58(2), 317–350.
- Leamer, E. E., Levinsohn, J., 1995. International trade theory: The evidence, in: Grossman, G. M., Rogo, K. (Eds.), *The Handbook of International Economics*, Elsevier, vol. III, pp. 1339–1394.
- Liu, X., Buck, T., 2007. Innovation performance and channels for international technology spillovers: Evidence from Chinese high-tech industries. *Research Policy* 36(3), 355–366.
- Malerba, F., Nelson, R., Orsenigo, L., Winter, S., 2007. Demand, innovation and the dynamics of market structure: The role of experimental users and diverse preferences. *Journal of Evolutionary Economics* 17(4), 371–399.
- Melitz, M., 2003. The impact of trade in intra-industry reallocations and aggregate industry productivity. *Econometrica* 71(6), 1695–1725.
- Michelacci, C., Silva, O., 2007. Why so many local entrepreneurs? *Review of Economics and Statistics* 89(4), 615–633.
- Moretti, E., 2004. Workers’ education, spillovers, and productivity: Evidence from plant-level production functions. *American Economic Review* 94(3), 656–690.
- Myers, S., Marquis, D. G., 1969. *Successful Industrial Innovations*, National Science Foundation 69-17., U.S. Government Printing Office, Washington D.C.
- Nese, A., O’Higgins, N., 2007. Attrition bias in the Capitalia panel. *International Review of Economics* 54(3), 383–403.
- OECD, 1997. *Proposed guidelines for collecting and interpreting technological innovation data: Oslo manual.*, OECD.
- Parisi, M. L., Schiantarelli, F., Sembenelli, A., 2006. Productivity, innovation and R&D: Micro evidence from Italy. *European Economic Review* 50(8), 2037–2061.
- Puga, D., Treffer, D., 2010. Wake up and smell the ginseng: International trade and the rise of incremental innovation in low-wage countries. *Journal of development economics* 91(1), 64–76.
- Rauch, J., 1996. Trade and search: Social capital, sogo shosha, and spillovers. NBER Working Paper No. 5618 .

- Rauch, J., Trinidad, V., 2003. Information, international substitutability and globalization. *American Economic Review* 93(3), 775–791.
- Rauch, J., Watson, J., 2003. Starting small in an unfamiliar environment. *International Journal of Industrial Organization* 21(7), 1021–1042.
- Rosenberg, N., 1982. *Inside the Black Box: Technology and Economics*, Cambridge University Press.
- Salomon, R. M., Shaver, J. M., 2005. Learning by exporting: new insights from examining firm innovation. *Journal of Economics & Management Strategy* 14(2), 431–460.
- Santarelli, E., Sterlacchini, A., 1990. Innovation, formal vs. informal R&D, and firm size: Some evidence from Italian manufacturing firms. *Small Business Economics* 2(3), 223–228.
- Schmookler, J., 1966. *Invention and economic growth*, Harvard University Press, Cambridge, M. A.
- Segerstrom, P., 1991. Innovation, imitation and economic growth. *Journal of Political Economy* 99(4), 807–827.
- Staiger, D., Stock, J., 1997. Instrumental variables regression with weak instruments. *Econometrica* 65(3), 557–586.
- Sutton, J., 1998. *Technology and market structure: Theory and history*, MIT Press, Cambridge M.A.
- Verhoogen, E., 2008. Trade, quality upgrading and wage inequality in the mexican manufacturing sector. *Quarterly Journal of Economics* 123(2), 489–530.
- Vernon, R., 1966. International investment and international trade in product cycle. *Quarterly Journal of Economics* 80(2), 190–207.
- Wagner, J., 2007. Exports and productivity: A survey of the evidence from firm-level data. *The World Economy* 30(1), 60–82.