Export-led innovation among European firms: demand and technological learning effects

Claudio Fassio

School of European Political Economy (SEP), Luiss Guido Carli, Rome

& BRICK Collegio Carlo Alberto, Moncalieri.

VERY PRELIMINARY VERSION

Abstract

This paper investigates the effect of exporting activities on the innovation strategies of European firms in France, Germany, Italy, Spain and UK. The paper puts forward the hypothesis that such a positive effect is driven two main mechanisms. The first is a technological learning effect that allows firms active in international markets to benefit from foreign knowledge spillovers in technologically advanced markets and decrease their research cost for the development of innovations. The second is a demand effect induced by fast-growing foreign markets that increase the potential output of firms. The empirical analysis, which addresses important endogeneity issues related with the strategic choice of the markets of destination operated by firms, shows that the two effects induce the adoption of different innovation strategies. While the technological learning effect positively affect the decision of firms to introduce brand new product innovations, the demand effect fosters the adoption of efficiency and imitation strategies. The paper shows that the effect of exporting activity on innovation strategies crucially depends on the type of export destinations. The lower levels of the technological learning effect which is found among the export destinations of Italian and Spanish firms might represent a possible obstacle for the ability of these country to increase their future innovative capacities.

JEL classification: F10, O33, P51
Keywords: Exports, Innovation strategies, European Union economics

1. Introduction

This paper analyzes the effect of exporting activity on the innovative performances of European firms. While there is a general consensus on the fact that firms that are able to innovate are more likely to access international markets and export (Roper and Love, 2002; Melitz, 2003; Becker and Egger, 2009), an increasing attention is now paid to investigate the effect of being an exporter on innovative outcomes. The intuition is that by operating on international markets firms are induced to implement new organizational and technological routines that eventually allow them to increase productivity levels. A growing literature has analyzed the causal link existing between exporting activity and innovation (Liu and Buck, 2007; Fafchamps et al., 2008; Damijan et al., 2010; Lileeva and Trefler, 2010; Bustos, 2011, Bratti and Felice, 2012), finding, in most of the cases, that exporting activity indeed increases the probability to introduce innovations at the firm level.

However this literature has not yet identified the specific mechanisms that drive the causal effect of exports on innovation: why and how exporting increases the probability to introduce new products and adopt new technologies? Moreover the literature is also not unanimous about which types of innovations are more affected by exporting activity: positive effects have been found in different empirical analyses on, respectively, product innovation, process innovation or patent applications.

In this paper I put forward the hypothesis that exporting activity affects the decision to introduce innovations through two differentiated mechanisms: a "technological learning effect" which allows firms to learn to innovate from foreign clients, suppliers and competitors when they are active in very technologically-advanced foreign markets and a "demand effect" which pushes firms to innovate when they are active in markets with a high growth of demand. The advantage of this approach is twofold: first exporting is not anymore considered to have a homogenous effect on innovation, on the contrary every foreign market can be considered as a combination of these two inducement effects on innovation. Indeed once the assumption that all foreign markets are the same is relaxed, it is possible to assume that these two effects can substantially differ between each other. This is especially true considering global markets today, in which growing markets (especially in emerging countries) are not necessarily also technologically-advanced, while very technologically advanced markets (especially in Europe) often have very slow demand dynamics. The second contribution of the paper relies on the fact that the positive effect of exporting activity is not assessed on a generic measure of innovation: each of the two effects introduced is supposed to have differentiated effects on different types of innovation strategies innovations. Indeed while the main contribution of the technological learning effect is to decrease the relevant research costs related with the introduction of innovations, the demand effect on the contrary, by increasing the potential number of units sold, increases the incentives to adopt strategies that take advantage of the increase of the market size.

It is particularly interesting to analyze the role of the technological learning and demand effect of export activity among firms belonging to European countries and specifically to the largest European economies. Indeed most of the results obtained so far in the literature on the link between exports and innovation concern in most cases emerging economies (such as Argentina, Mexico and Morocco) or small and export-oriented economies (Slovenia). Instead it is important to test if those findings hold also for large and advanced countries, like the European ones. Furthermore the recent debate related with the upsurge of internal trade imbalances inside the Euro-area has shown the

importance to understand the main drivers of competitiveness within a single monetary union (Chen, Milesi-Ferretti and Tressel, 2013; International Monetary Fund, 2014; Canofari, Esposito, Messori, Milani, 2014): export and innovation activity are crucial elements of the dynamics of competitiveness between firms and aggregate economies in general (Altomonte et al., 2013). If export activity, and the relative technological learning and demand effects, is important to explain innovative strategies then this mechanism might induce very divergent paths between firms active on international markets and firms that cannot take advantage of these potential benefits. These dynamics are able to affect competitiveness gaps both within and between countries.

In the paper I test the relevance of the technological learning and demand effect of exporting activity taking advantage of the EU-EFIGE/Bruegel-UniCredit dataset (European Firms in a Global Economy), which includes detailed firm-level information about export activity and innovation performances of a large number of firms active in the five largest European economies (Germany, France, Italy, Spain and United Kingdom) in the period 2007-2009. The dataset includes information on the most important export destinations of exporting firms. Therefore I am able to build an integrated dataset in which to each exporting firm I associate a demand and technological learning effect, as proxied respectively by the sectoral growth of imports of the markets of export destination (in the same sector of the exporting firm) and by the sectoral intensity of expenditures in Research and Development of the markets of export destination. These two indexes that proxy the demand and the technological learning effects are included in a probability linear model that explains the introduction of different innovation strategies: respectively efficiency strategies, imitation strategies and truly innovative strategies.

The empirical specification addresses the important endogeneity issue related with the fact that firms can strategically chose the locations of their exports precisely because they want to benefit from a high demand growth or by technological spillovers. Building on the previous literature I devise an instrumental variable strategy that takes advantage of the sectoral propensity at the national level to export to specific countries. The results show that indeed the positive effect of export activity on innovation can be explained by the working of the technological learning and demand effects. More specifically these two effects induce different economic rationales for the introduction of innovation strategies. The technological learning effect increases the probability to introduce product innovations because it decreases the relevant research costs related with the introduction of such innovations. On the contrary the demand effect, by increasing the potential number of units sold, increases the incentives to adopt efficiency strategies based on process innovations and product imitation strategies since both strategies become very profitable when the overall level of output increases.

The results are important for their policy implications: while all types of innovation strategies can have a positive impact on firms' performances, in advanced economies research-based product innovations -able to actually shift the world technological frontier- are those with the highest economic impact (Acemoglu, Aghion, Zilibotti, 2006) and also at the firm-level they are likely to have a greater effect on total factor productivity growth (Duguet, 2006). The country patterns investigated in the paper show that even after controlling for firms' size and for sectoral affiliation German firms that export have higher levels of the index that measures the technological learning effect and which favors truly product innovation, especially with respect to southern European

countries such as Italy and Spain. These results suggest that among southern European countries like Italy and Spain firms might lack an important incentive to introduce innovations that are able to increase their future innovative capacities and induce catch up processes within the European Union.

2. The effect of exports on innovation: the role of demand and technological learning

In order to analyze the effect of exporting on innovation it is necessary to understand through which mechanisms exporting activity is able to affect firms' innovation strategies. In this paper I will try to classify in two main categories the different explanations that have been advocated in the related literature to motivate the hypothesis of a positive link between exports and innovation: I will define them the technological learning effect and the foreign demand effect.

The first effect has often been labeled in the literature as the learning-by-exporting hypothesis. This hypothesis was first introduced in the literature that studies the behavior of exporting firms in middle-income countries. Among these firms it is found that exporting to advanced markets increases the overall productivity of firms. De Loeckeer (2007) finds that Slovenian firms who export are more productive than non-exporters and that this effect is driven by firms who export to high income countries (such as Western Europe and North America). Also Verhoogen (2008) finds that increased access to foreign markets induces exporting Mexican firms to upgrade their quality in order to satisfy sophisticated markets. Similar findings are provided by Fafchamps et al. (2008) on a sample of Moroccan manufacturing firms.

According to this hypothesis being active in international value chains allows firms to benefit from technological spillovers. In other words firms learn to improve and upgrade their technologies thanks to the interactions that occur both on the supply side (knowledge spilling from foreign suppliers/competitors) and on the demand-side (knowledge spilling from foreign specialized users).

This effect was found to be relevant also among firms in advanced economies, such as western European countries. Salomon and Shaver (2005) have investigated the learning by exporting effect on a sample of Spanish firms and found that indeed exporting has a positive causal effect on innovation. Moreover Salomon and Jin (2008) found that firms that are more technologically advanced are better able to exploit the benefits of exporting. Crespi et al. (2008) have been the first who actually tried to use a direct measure of technological spillovers stemming from the demand side, that is the access to relevant information from foreign buyers. Their results show that having access to this type of knowledge from foreign customers increases the productivity of a firm. Also Bratti and Felice (2012) suggest that the positive effect on product innovation that originates from exporting activity among Italian firms is probably due to increased knowledge of the markets in which firms are exporting.

A corollary to these analyses is represented by Crinò and Epifani (2012) who find that Italian firms with low technological capabilities (as indicated by lower total factor productivity) are more likely to export to low income countries. Their results can be considered as a counter-evidence: indeed

exporting is not to be considered a homogenous type of inducement on innovation and productivity, on the contrary it might even be the case that exporting is correlated with lower productivity when destination markets are low income countries.

The second explanation of the positive effect of exporting activity on innovation and productivity is related to the role of foreign demand. Since the early contributions of Schmookler (1966) demand growth in general has been considered among the main determinants of innovation. Therefore the access to a large or growing foreign market should induce firms to invest in new technologies and new products since the expected profits are likely to increase with the size of the market and the firms' revenues. The main contributions on the role of foreign demand come from the trade literature: exporting activity is considered as an increase of a firm's output market and trade liberalization is often described as the increased possibility to access new foreign markets.

On the theoretical side Desmet and Parente (2010) show that exporting, by increasing the firms' market size, will increase also the willingness of firms to innovate. More specifically they suggest that exporting firms, faced with a larger demand, will be likely to increase their overall size and invest mainly in process innovations. Lileeva and Trefler (2010) and Bustos (2011) propose similar models in which the decrease of bilateral tariffs induces firms to pay the fixed costs associated with the investments in technology, because of the increased access to a market of a larger size. The two papers exploit a very similar research setting: Lileeva and Trefler (2010) exploit the effect on Canadian firms of a reduction of tariffs with the United States, while Bustos (2011) analyzes Argentinean firms exposed to a tariff-cut with Brazil: in both cases the authors find that the higher the exposition to the tariff-cuts the higher will be the level of innovative investments.[1] Using a similar setting, but with Italian firm data, Accetturo et al. (2014) suggest that the increase of the foreign market size should induce product innovation (as proxied by patents) especially among large firms. Woerter and Rope (2010) in a panel dataset on Swiss and Irish firms find very limited effect of foreign demand among Swiss firms on product innovation and share of new products. Piva and Vivarelli (2007), using a sample of Italian firms, find that the demand pull effect is stronger for firms with a high export intensity, that is exporting firms exhibit a higher innovation elasticity with respect to sales.

On the basis of the contributions presented in this section it becomes clear that the positive effect of exporting activity on innovation is due to two quite different underlying mechanisms. An exporting firm might be induced to introduce new technologies because it is benefitting from foreign technological spillovers on the supply or demand side which decrease the fixed cost of innovating (the technological learning effect), or it might be induced to upgrade its technology because the increased foreign market size makes it more profitable to increase the efficiency of the production processes or to introduce new products (the demand effect). This leads to considering export destinations as heterogeneous in terms of the inducement effect that they exert on firms' innovative efforts, since not all export destinations include the same combinations of these two effects. Exporting to different markets might increase either the technological learning effect or the demand

[1] The two papers differ in the prediction of which firms should be more induced to upgrade their technologies: according to Lileeva and Trefler firms with initial low productivity should be affected the most, while according to Bustos firm in the third quartile of the initial productivity distribution should be affected more.

effect. In the next section I will investigate how these two effects can also lead to quite different innovative strategies chosen by firms.

2.2 Hypotheses

In order to understand which type of effect will the technological learning and foreign demand mechanisms exert on firm's innovation choices, it is necessary to stress the fact that innovation is not a uniform bundle of activities and that innovation strategies can be different from one to another. A limit of the existing literature that studied the export-innovation link is to consider innovation in general as an undifferentiated economic activity, or to consider different types of innovation (for example process or product innovation) as interchangeable. On the contrary different types of innovations serve different rationales and the conditions in which firms are operating will induce them to adopt different types of innovation strategies accordingly. The technological learning and demand effects of export activity affect firms' economic performances in two different ways. The technological learning effect allows firms to benefit from foreign knowledge spillovers which decrease the internal research costs necessary to develop new innovations. The demand effect instead increases firms' potential output and the overall number of units sold. The technological learning and demand effects hence will have an effect on specific innovative outcomes according to the way in which they affect the firms' rationales for innovating. In this section I will introduce three common types of innovation strategies and I will discuss to what extent the technological learning and demand effects of exporting activity induce firms to adopt each of these possible strategies.

Efficiency strategy. A possible rationale for the introduction of innovations is the increase of the efficiency of the productive processes, that is the decrease of the cost of inputs given a certain quantity of output. The ideal way to achieve this goal is the introduction of process innovations, which are typically devised to increase the efficiency of the productive process.[2] Schmookler (1954) showed that the incentive to introduce process innovations increases with the quantity of output produced, since the efficiency gains on each unit produced will be multiplied by a larger number of units. Therefore when firms experience an increase of their market, and therefore of their units produced, they will be induced to adopt process innovations since the efficiency gains achieved will apply on a larger number of unit sold. Scherer (1991) as well as Cohen and Klepper (1996) provide theoretical and empirical evidence that the increase of the number of units sold induces firms to dedicate more research efforts towards process innovations rather than towards product innovation. According to this perspective it is clear that the demand effect of exporting activity, by increasing the potential output of exporting firms, will typically increase the incentive for firms to improve the efficiency of their productive processes. On the contrary the technological learning effect is not expected to have an important role for this innovation strategy. Indeed as Pianta and Bogliacino

[2] The introduction of a product innovation often leads to the modification of existing productive processes, therefore product innovations often leads also to process innovations to process innovation. At the same time the introduction of a process innovation often entails also the modification of the existing line of products. This complementarity of product and process innovation has been widely acknowledged (Miravete, Pernìas, 2006) and should be always taken into account. However for the sake of this analysis process innovation alone can still be considered as a good proxy of the efficiency rationales: a firm who wants to invest to increase its efficiency levels will mainly consider the introduction of process innovations.

show (2011) efficiency strategies that rely on process innovations are to be considered as alternative to other innovation strategies that require high investments in research activities. Since research costs are not a relevant factor for the decision to adopt efficiency strategies, the technological learning effect will not have a strong inducement effect on this strategy.

Hypothesis 1: The incentive for firms to adopt efficiency strategies are positively affected by the foreign demand effect of export activity.

Imitation strategy. In most cases firms might decide to introduce new products that imitate existing products already developed by other firms. As Mansfield et al. (1981) have pointed out the advantage of imitation consists in the possibility to minimize research costs and the time-to-market. The main disadvantage consists in the low levels of mark ups on the new products, since the firm will not be the only one introducing that product innovation. In this case the technological learning effect which decreases the research costs of innovation will not affect the decision to adopt imitation strategies, since research costs are already extremely low. Moreover Cohen et al. (1996) show that when the rate of increase of demand is high the incentives for firms to speed up the development of new products increase. Since the main benefit of imitation strategies is to reduce the time to develop a new innovation, an increase of the market size driven by foreign demand will induce firms to quickly introduce new products on the markets and will foster imitation strategies.

Hypothesis 2: The incentives for firms to adopt imitation strategies are positively affected by the foreign demand effect of export activity.

Product innovation strategy. The introduction of a brand new product innovation allows firms to earn a temporary monopolistic profit on the products sold, but entails very high research costs and long development processes. The technological learning effect allows firms to decrease research costs through knowledge spillovers stemming from foreign users or foreign suppliers. Since research costs are of crucial importance for brand new innovative strategy the technological learning effect, which decreases such costs, will have a positive impact on this innovative strategy. Indeed the literature that focuses on the role of sophisticated users (Von Hippel, 1986; Malerba et al., 2007) shows that interactions with users that are able to increase the firms' competences typically leads to brand new product innovations, rather than process innovations, and this is confirmed also for firms that operate on international markets, as shown by Bratti and Felice (2012B).

Hypothesis 3: The incentives for firms to adopt product innovation strategies are positively affected by the technological learning effect of export activity.

3. The empirical strategy

3.1. A simple model

In order to test the hypotheses about the effect of exports on firms' innovative outputs, I introduce the following simple linear probability model, in line with many of the previous studies on the export effect on innovation and productivity. In such a setting the probability to introduce any of the different innovation strategies *y* of firm *i* are a linear function of the firm's past exporting activity.

$$y_{it}^{s} = c + \beta EXPO_{it-1} + \delta Z_{it} + \mu_j + \nu_r + \rho_c + u_{it} \quad (1)$$

Where *s= efficiency strategy, imitation strategy, innovation strategy*

y_{it} indicates whether firm *i* implemented an innovation strategy *s* in period *t*. Therefore there is an equation for each of the three possible strategies implemented by the firm. $EXPO_{it-1}$ is a dummy equal to one if a firm exported in *t-1* and equal to zero if the firm did not export in time *t-1*. Z_{it} includes a set of firm-level control variables, while μ_j , ν_r and ρ_c control respectively for sector, regional and country effects. The idiosyncratic error term is denoted by u_{it}. While the literature so far has only focused on the size and sign of the β coefficient of being an exporter, here the hypothesis is that for each firm *i* the marginal effect of exporting on innovation activities is a linear function of the technological learning effect *L* and the demand effect *D* of exporting: indeed being an exporter means that a firm has been exposed in time *t-1* to the two different effects. Therefore it is possible to write:

$$\beta_i = \gamma_1 L_{it-1} + \gamma_2 D_{it-1} \quad (2)$$

Where for each firm the coefficient of the export dummy depends on the specific impact of the two identified effects. Substituting (2) into (1) we obtain the following specification:

$$y_{it}^{s} = c + \gamma_1 \left(L_{jt-1} * EXPO_{it-1}\right) + \gamma_2 \left(D_{jt-1} * EXPO_{it-1}\right) + \delta Z_{it} + \mu_j + \nu_r + \rho_c + u_{it} \quad (3)$$

To ease the notation the interactions terms will be simply denoted as T_1 and T_2, as follows:

$$y_{it}^{s} = c + \gamma_1 T_1 + \gamma_2 T_2 + \delta Z_{it} + \mu_j + \nu_r + \rho_c + u_{it} \quad (4)$$

Hence the two variables of interest are $T_1=0$ if a firm did not export in *t-1* and $T_1=L_{it-1}$ if the firm exported in 2004. Also T_2 will be equal to zero if a firm did not export in time *t-1* and $T_2=D_{it-1}$ if the firm exported in the previous time period. Since the specification of the model is suitable for all firms, and not only for exporting firms, it will avoid to incur in the selection bias problems that typically occur when the analysis is performed only on exporting firms. According to the hypotheses spelled out in Section 2.2 the two coefficients γ_1 and γ_2 are likely to differ according to the type of innovation strategy considered.

3.2. Data

The data used is the EU-EFIGE/Bruegel-UniCredit dataset, a database collected within the EFIGE project (European Firms in a Global Economy), which includes detailed firm-level information

about the destinations of exports and the innovation performances of a large number of manufacturing firms active in several European countries in the period 2007-2009. For this analysis I will use firm-level data from the five largest European economies, i.e. Germany, France, Italy, Spain and United Kingdom. The EFIGE dataset is an extremely rich dataset with harmonized information across the different countries about firms' structural information (size, group affiliation, ownership structure) as well as information about the labor force, the innovation strategies and the innovative investments. Moreover the database also includes detailed information on the level of internationalization and on the levels of vertical integration (see Altomonte, Aquilante, 2012). The great advantage of the EFIGE dataset is that it has detailed information on both the innovation strategies adopted by firms and on the specific destinations of their exports. It is hence possible to know what type of innovation strategies were implemented by each firm and, for the firms who exported, the main markets of destination of their exports. Through this last information it will be possible to build a measure of the technological learning and demand effect of exporting. The main limit of the dataset is the fact that it is only a cross-section (there is only one wave of the EFIGE survey so far) which makes it more difficult to address causality issues: for this reason instrumental variable strategies will be introduced in the empirical analysis.

Dependent variables.
In order to identify the possible types of innovation strategies three dependent variables will be used: each of them indicating a specific innovation strategy, as outlined in Section 2.2.

Efficiency strategies are proxied by a dummy that is equal to 1 if a firm introduced a process innovation in the time period 2007-2009 and zero otherwise.

Imitation strategies are proxied by a dummy variable that is equal to one if in the time period 2007-2009 a firm introduced at least one new product, but declared that the innovative sales from new products were due to products only new for the firm and not new for the market: this type of product innovation is the one that corresponds better to the concept of imitation.

Innovative strategies are proxied by a dummy variable that is equal to 1 if in the time period 2007-2009 a firm introduced a product innovation that is new to the market and it also applied for a patent. This combination of product innovation and patent is chosen in order to have a measure of an innovation that is really new for the market. Indeed previous work with innovation surveys has shown that the fact that a firm claims to be the first to introduce an innovation might not represent a proof that the product is really innovative[3]: combining it with the application for a patent (which is necessarily linked to a technological novelty) seems a good way to decrease this risk.

Independent variables.
The EFIGE dataset asked firms whether they exported any of their products before 2008,[4] that is before the 2007-2009 period of observation to which the innovation strategies refer. Moreover to

[3] This is especially true when one considers exporting firms: the question about whether a product is new to the market or not risks to be too vague. For example a small firm which only knows its domestic market might consider a new products with little innovative content as new to the market. On the contrary a large and internationalized firm operating in many markets might consider a very innovative product as not new to the market because in some other markets it might have been already introduced by some leading competitor.
[4] The survey specifically asks firms to focus on the export activities which the firm carries out from the home country, disregarding the sales made through third countries (Altomonte, Aquilani, 2012). This distinction allows to clearly

the firms who declared export activities the survey asks to indicate the three main destinations of their export activities and for each of these destinations it asks whether the activity in the country started before 2004. On the basis of this information I build a dummy variable (0/1) equal to one if a firm has been exporting its products in the time span 2004-2008, that is in the 5 years before the period considered for the introduction of innovations (2007-2009). This is a first way to decrease the problems of simultaneity, by introducing a relevant time lag between export and innovation activities.

The information about export destinations also allows me to identify *long-term* export destinations, which have a high degree of persistence for the firms: indeed I only consider export destinations in which the firm was already active before 2004 and was still present in 2008. On the basis of this information, combining it with the sectoral affiliation of each firm, it is possible to build the two main variables of interest that measure the technological learning effect and the demand effect stemming from export activity, by attributing to each combination of sector and foreign market destination an index of technological advancement and market growth. The main assumption behind this approach is that the possibility to learn through exporting activity (technological learning) and to benefit from the increase of the market (demand) does not depend on the features and dynamics of the overall economy of the countries of destination, but rather by the characteristics of the same sector in which the firm is active. As a matter of example this implies that for a French firm active in the textile industry which exports to the United States the level of technological spillovers and demand will depend on the characteristics and the dynamics of the textile industry in the United States and not on the overall dynamics of the United States economy. This approach seems legitimate, since firms, especially small and medium-sized firms, are often working in a specific market, therefore the features of the economy at the aggregate level may have little or no influence at all on their economic decisions[5]: a thinner, sector-based, measure is hence to be preferred. However the advantages of this strategy increase only up to a certain threshold: if the sectoral disaggregation is too thin there is the risk to miss important inter-sectoral effects. Indeed a firm necessarily buys inputs and sells outputs to other firms that perform different economic activities along the vertical supply chains. Restricting too much the sectoral focus may result in losing these interactions occurring across sub-sectors. In order to take into account both these effects the 2-digit (ISIC. Rev. 3) sectoral aggregation was chosen: this classification distinguishes between manufacturing firms that do completely different economic activities (such as the pharmaceutical industry and the automotive sector), but at the same time aggregates across similar economic activities (such as the production of basic chemicals and the production of plastic products).[6]

---

distinguish the export effect from other effects related with the internationalization activities, such as foreign direct investments or arm's length agreement of outsourcing

[5] Different is the case of large multinationals that operate in very heterogeneous market segments: in that case focusing only on one sector might not be the correct choice. However the share of firms with more than 500 employees on the total sample is very little, lower than 3%. In the empirical analyses I checked whether this is a relevant problem by excluding large multinational firms from the sample: the results were not affected at all by the exclusion of this small group of firms.

[6] Another possibility to catch the inter-sectoral linkages would be to use cross-sectoral input-output tables to weight each sector by its relevance among the revenues and purchases of the other sectors. This approach has two complications: the first- due to the impossibility to have detailed input-output data for each possible destination country- is the need to adopt an arbitrary world-level average of input-output tables. The second is the necessity to

Technological learning effect. The technological learning effect can be proxied by the level of technological sophistication of the country *c* in which a firm *i* is exporting, in the specific 2-digit sector *j* in which the firm is active. According to the hypotheses of the "learning by exporting" literature, the higher is the level of technological advancement of the market/sectors of destination, the higher will be the possibility for the exporting firm to acquire new knowledge and new useful routines to be eventually incorporated in new products or new processes. The share of Research and Development (R&D) expenditures over the total value added of a sector can be considered a reliable proxy of the general level of technological advancement of a sector in a country.[7] For each national sector indicated as a *long-term* export destination by the firms in the EFIGE sample, I calculated the level of business R&D intensity using data from the OECD-STAN, integrating it with data from the UNIDO and the WorldBank: to each country-sector the average value of R&D intensity for the years between 2000-2004 was used. In this way the technological intensity of export destinations corresponds to the pre-2004 period to which firms refer when they indicate their export-markets and, at the same time, the use of the average level of R&D intensity over the four years should exclude possible outliers due, for example, to sudden decreases/increases of value added in specific years, which would bias upward/downward the R&D intensity. The technological learning hence corresponds to the highest level of sectoral R&D intensity among the three main countries of destinations indicated by the firm, conditional on the fact that the firm was already exporting in that market in 2004.[8]

$$L_{it-1} = \max(\mathrm{R\,\&\,D}_{cj}) \qquad (5)$$

Where $c = 1, \ldots, 3$

Demand effect. Contrarily to the technological learning effect there have been already some attempts to measure the effect of foreign demand on the innovative performances of exporting firms: Bratti and Felice (2012) use the level of GDP per capita of export destinations weighted by the relative distance. Accetturo et al. (2014) instead use import growth as a proxy of the growth of demand. Here I follow the second strategy and calculate the rate of growth of imports in each specific 2-digit sector for each export destination in the period 2004-2007, the data come from

---

choose between input or output weights for each single sector (or use both). This arbitrary choice would depend on the belief that the export-effect depends more from upstream or downstream vertical relations. As a matter of example one should decide if a German firm exporting car break systems to Japan benefits more from its customers (the Japanese automotive producers) or from its suppliers (the Japanese suppliers of components). Even if this seems a possibly interesting avenue of research, for the time being the simpler 2-digit sectoral approach was preferred.

[7] Another possibility could be to use the number of patents application by national firms in each specific sector. However this approach is not straightforward because it is necessary to match sectorial classifications with the technological classes of patents. Moreover one should also decide which patent office should be used (either the EPO or USPTO), this would introduce another arbitrary decision. Also Total Factor Productivity (TFP) is sometimes used to assess the level of technological advancement of a national sector: however TFP is a less thinner measure of technological sophistication, since its dynamics might be due to nono-technological factors, such as the changes in the competition structure of a sector.

[8] Also the average level of R&D intensity among the three export destinations might be an appropriate measure of the technological learning effect: however the measure used in the paper seems preferable because it is likely that knowledge spillovers and opportunities to learn will mainly proceed from the firm's most sophisticated market. In other words using an average value means that if company A exports to only one advanced market and company B exports to an equally advanced market and a less advanced market, the average value of technological learning effect would be lower for company B. This does not seem a legitimate choice since both companies have the same opportunity to learn from the most advanced market in which they export.

COMTRADE and are calculated in US dollars. Since I am only considering *long-term* export destinations in which firms were already active in 2004 and were still active in 2008 I can be sure that from 2004 to 2007 these firms have been continuously exporting to that specific country which experienced that rate of growth of imports in sector *j*. The foreign demand effect therefore is:

$$D_{it-1} = \sum_{c=1}^{3} \left(imp_{jc2007} - imp_{jc2004} \right) / 3 \qquad (2)$$

Where $c = 1, \ldots, 3$

And *imp* is the log of imports from country *c* and sector *j* in time *t*. This measure is able to capture the extent to which the markets in which the firm was exporting have grown in the period before the decision to adopt any of innovative strategies identified above. Again I adopt a lag specification in order to restrict the focus on the sectoral import growth for the period 2004-2007 of the markets in which firms were already operating in 2004. This allows to avoid a first possible reverse causality issue: indeed a growing market typically attracts exporting firm. However my strategy allows to rule out this possibility: because I only consider the demand effect for markets in which firms were already there in 2004, that is before the exogenous high (or low) growth of that market in the period 2004-2007.

Home effects. In order to isolate the export effect on innovation, it is also necessary to distinguish between the effect on innovation that is brought by foreign activity and the effect of the domestic market in which the firm is active. Indeed both the growth of domestic demand and the level of technological development in the home country are likely to influence the decision of exporting firms, since in almost all of the cases firms sell their products both in domestic and foreign markets. Therefore the model also includes a measure of the growth of the internal markets, as proxied by the growth of value added in the national 2digit sector of belonging of each firm (taken from OECD-STAN database), and a measure of the technological advancement of the sector in which the firm is active, as proxied by the share of R&D expenditures over total value added in the national 2digit sector of belonging of each firm (source OECD-STANBERD database).

Structural variables. The model includes controls for structural characteristics of the firms such as employment size, age of the firm, group affiliation (controlling whether the firms is member of a national group or foreign group) and the type of ownership control, through a dummy that indicates whether the chief executive order (CEO) is the individual who controls the firm or a member of the controlling family.

Innovative capacity. Another set of variables is related with the innovative capacity of the firm. The first variable is the percentage of the total turnover that a firm invested in R&D on average in the years 2007-2009. The model also controls for the level of human capital, therefore a dummy is included which is equal to 1 if the firm has a higher share of graduate employees with respect to the national average share of graduates and zero otherwise. The quality of the labor force is also controlled for with a variable that measures the share of employees that were working for the firm with a fixed-term contract. Finally, since Information and Communication Technologies (ICT) are an important prerequisite for many innovative activities the model also includes a dummy that is

equal to 1 if the firm has access to a broadband connection with high-speed transmission of digital content and zero otherwise.

Internationalization activity. In order to identify the effect of export activity on innovation strategies it is extremely important to distinguish between export activity *per s*e and internationalization activities in their broader spectrum. Indeed internationalization and export activities are intrinsically intertwined, therefore not accounting for the former factor would imply the risk to have an unobserved variable that is positively correlated both with export activity and with innovation activities.. This factor has been often overlooked by previous studies, with the risk to confuse between the two effects of export and internationalization activities on innovation. The model therefore includes two dummies that check if if the firm runs at least part of its production activity in another country through direct investments or through contracts and arms' length agreements with companies located in the foreign market. Another dummy variable controls if the firm has any foreign affiliates. Finally I also control for the geographic localization of the main competitors of the firm with a set of dummies that control if the firm's competitors are located in the domestic, European, or North American markets, or if they are located in other countries.

Vertical integration. Especially the technological learning effect might be affected by the level of vertical integration of a firm: as a matter of example the possibility to learn from foreign customers will change a lot if the firm sells directly to consumers or to other firms. In general, as Gereffi et al. (2005) suggests, the possibility to learn from international customers is higher for specialized suppliers who are able to upgrade their competences through repeated interactions with their clients. Therefore I introduce a measure of vertical integration with a variable that measures the percentage of purchased intermediate goods in 2008 over annual turnover. Moreover I introduce also three other dummy variables that indicate the percentage (on average) of the firms' turnover made up by sales of produced-to-order goods.

The model also controls for country effects, 2-digit sector effects and regional effects at the nuts-2 level.

3.3. Descriptive statistics

Table (1) presents the aggregate descriptive statistics of the main variables in the whole sample that includes French, German, Italian, Spanish and British firms. The most diffused innovation strategy is the efficiency strategy, which is adopted by more than 40% of firms, followed by imitation strategies (17%) and truly innovative strategies, which are implemented only by 11% of firms. Firms with up to 50 employees represent the large majority of the overall sample (75%). Only a small share of firms belong to national or foreign groups – respectively 13% and 8%. The variables related with internationalization strategies show that only a limited fraction of firms (5%) has foreign direct investments abroad and about 4% chose to produce abroad through arm's length contracts with foreign partners. The majority of firms considers domestic competitors as the most important, followed by European competitors (43%) and competitors in other areas (27%); competitors from the United States are considered very important only by 11% of firms. The variables that proxy the level of vertical integration show that for more than 60% of firms the sales-

to-order share of their product is greater than 70%, indicating that most of the firms have established clients and they produce on the basis of their specific requests.

INSERT TABLE (1) ABOUT HERE

About 40% of firms were already exporting in 2004: for each of them it was possible to calculate their respective index of technological learning effect -as proxied by the intensity of R&D expenditures of the sectors and markets in which they were already exporting in 2004- and of the foreign demand effect that is measured by the average growth of imports in their specific sector of the markets of export destination. Figures (1) and (2) display the distribution of the two indexes for the subset of firms who were exporting in 2004. The two histograms are quite different: while the technological learning effect displays a very skewed distribution, the demand effect has a more smoothed normal-like distribution. This shows that in the case of R&D intensity the majority of firms exports to markets that have values of R&D intensity below 0.2, with only a minority of firms exporting in very advanced foreign markets. On the contrary the role of outliers is much less important for the demand effect.

INSERT FIGURES (1) AND (2) ABOUT HERE

It is also interesting to note whether there are important country patterns in export propensities and innovation strategies: therefore in Table (2) I use a very simple OLS framework to investigate the existence of country effect, controlling for sector and size effects. In columns (1) and (2) of Table (2) I check if there is a significant country effect for the probability of being or not an exporter in 2004: the reference country used is always Germany, which is supposed to be the most advanced country, therefore the country-dummies coefficients can be interpreted as the difference of the other countries from the German coefficient. When I only use the country dummies I find a positive and significant coefficient for Italian and UK firms, however when I include controls for sector and size effects I find that also Spanish and French firms have a higher propensity to export with respect to German firms. Columns (3) and (4) show that efficiency strategy are more common in Italy, Spain and UK, with respect to France and Germany. Imitation strategies are more common in Germany and especially in Spain. Finally when I simply use country dummies I find that truly innovation strategies are less frequent in all countries with respect to Germany, however when I introduce controls for size and sectors I find instead that only France and Spain still display a negative (but not significant) coefficient. In Table (3) instead I check whether significant country differences exist for what concerns the intensity of the technological learning and demand effect of exporting. Contrarily to the results of Table (2), in which results were mainly driven by composition effects due to the size of firms and the sector specialization of countries, Table (3) shows that the technological learning effect is stronger for German firms even after controlling for size and

sectors, specifically it is significantly lower in Italy and Spain. The demand effect displays negative coefficients in Spain, France and UK, while in Italy is slightly higher than in Germany.

INSERT TABLES (2) AND (3) ABOUT HERE

These first descriptive statistics suggests that while differences in exporting propensity and innovation are mainly driven by size effects (German firms are on average larger) and industrial specialization effects (Italian and Spanish firms are more often in low-tech industries), on the contrary the demand and especially technological learning effect show that German exporting firms are indeed more exposed to them. The next sections will show how these two effects, that differ markedly among firms and countries, have an effect on the propensity of firms to adopt specific innovative strategies.

3.4. Identification

The specification chosen needs to address important endogeneity issues: while D_{it-1} and L_{it-1}, i.e. the rate of growth of imports and the level of technological development of the main countries of export destination for each firm *i*, depend on exogenous macro-economic trends in trade activities and on the general level of development of a national sector, and they do not depend on the specific innovative strategies of the firms in the EFIGE sample. However the two variables are endogenous because the choice of a firm to export in a specific country *c* is not random: firms chose strategically the destination of their exports. The specification chosen, which considers only the effect on innovation activities performed between 2007 and 2009 of export destinations in which firms were present before 2004 allows to avoid reverse causality problems. However the fact that a firm exported in a specific country (with a specific demand growth and technological development level) in 2004 is related to unobservable characteristics that the model might be not able to control for, since the sample is a cross-section. For example past innovation activities might have allowed firms to start exporting in markets with high technological development (or demand growth) already in 2004 and, considering the high degree of persistence of innovation, these general unobserved abilities might also be an important determinant of the ability to adopt innovation strategies in the period 2007-09. In other words there can be unobserved factors that are correlated both with the decision to implement specific innovation strategies and with the choice of specific export destinations in terms of demand growth or technological advancement.

Therefore it is necessary to instrument T_1 and T_2 with a variable that is related with the probability to export in a specific country in 2004, but which is independent of firms' specific innovation activities. Following the previous literature on this topic (Bratti e Felice 2012) the identification strategy relies on the average propensity of firms in a certain national sector to export towards specific destinations. In other words the assumption is that in each country a firm will be more likely to export to the most common market destinations among the other firms of the same country which are active in the same sector. Taking advantage of OECD trade data (STAN Bilateral Trade

in Goods by Industry and End-use) it is possible to build an average of import growth and of R&D intensity for the most common export market destinations of each national sector. This new variable can be considered as a good candidate instrument, since the sectoral average will not be correlated with a firm's own innovation capacities and at the same time it is likely that this measure will be correlated with the actual export decisions of firms. However since it is likely that the relationship between this instrument and the actual behavior of firms will not be linear I introduce some further factors that are suppose to determine heterogeneous responses by firms to the treatment. The first factor is the regional propensity to export: the probability that a firm exports in the same market destinations of the average firm in its own national sector also depends on the general propensity to export of the firm's region, since this propensity varies quite a lot among regions in the same countries. Another factor that is likely to diminish the ability of the instrument to explain firms' export choices is related to the size of firms: very small firms will have in general a lower ability to export, regardless of the sectoral averages, since they face relevant obstacles to access foreign markets, represented by sunk and information costs. On the basis of these preliminary considerations I built the following instrument:

$$\hat{T}_{1it-1} = \sum_{c=1}^{25} w_j L_{jct-1} m_r$$

L_{jct-1} is the level of technological development proxied by the R&D intensity of the first 25 most-common c country-destinations of exports for the sector j in the specific European country in which the firm is active. w_j is the share of export to each of the destination of exports over the total exports of sector j. m_r is the share of exporting firms in each region on the total number of firms in that specific region. Finally in order to account for firm-size effects an additional instrument will be added in which $\hat{T}_{1it-1}$ is multiplied by a dummy (0/1) equal to one if a firm employment is equal or lower than 15 employees. The same procedure is used to instrument the demand effect T_2:

$$\hat{T}_{2it-1} = \sum_{c=1}^{25} w_j D_{jct-1} m_r$$

Where D_{jct-1} is the growth of imports between 2004 and 2007 of the first 25 most-common c country-destinations of exports for the sector j in the specific country in which the firm is active. w_j is the share of export to each of the destination of exports over the total exports of sector j. m_r is the share of exporting firms in each region on the total number of firms in that specific region. Also in this case $\hat{T}_{2it-1}$ is multiplied by a dummy (0/1) equal to one if a firm employment is equal or lower than 15 employees.

5. Results

Before estimating the importance of the technological learning and demand effect on firms' different innovative strategies I start with an OLS estimation of the linear probability models that explain the implementation of the three possible innovation strategies, using the fact of being an exporter in 2004 as the main independent variable. This will be useful for two reasons: first because

it will be a benchmark with respect to the previous literature and secondly because it will allow to show how the inclusion of the different controls of the model changes the export effect on innovation.

INSERT TABLE (4) ABOUT HERE

Table (4) displays the marginal effect of exporting on each of the three innovative strategies. In columns (1), (4) and (7) the model consists only of industry, region and country effects: the results show that exporting activity has always a positive effect on innovation, but the strength of this effect is stronger for efficiency and innovative strategies and weaker for imitation strategies. In Columns (2), (5) and (8) instead I introduce a first set of controls that measure the level of innovative investments and some structural characteristics of the firms such as employment, belonging to a group and the composition of the labor force. The results show that the inclusion of these controls decrease by almost half the coefficient of export activity in efficiency and innovative strategies. The decrease is smaller for imitation strategies, where the coefficients drops only by one fourth. The level of investments in R&D and the presence of skilled labor force is positively correlated with efficiency and innovative strategies and only mildly with imitative strategies. This is quite in line with the expectations, since in order to innovate firms are required to develop their own innovative capacity, while imitation strategies do not require high investments in the development of technological capabilities. Finally in column (3), (6) and (9) I introduce also the other controls related with the level of internationalization and vertical integration of each firm, as well as the sectoral measures of domestic demand growth and domestic intensity of R&D. The inclusion of these further controls decreases by roughly one third the impact of the export dummy in all the three specifications, showing that their inclusion is important in order to properly identify the effect of exports on innovative strategies. Internationalization choices especially affect the decision to adopt truly innovative strategies, this the case for FDI and production performed abroad through arms' length contracts, as well as the existence of foreign affiliates. Finally the variables related with the vertical integration of firms show that the higher the share of intermediate goods over total sales the higher will also be the propensity to adopt efficiency and truly innovative strategies.

INSERT TABLES (5) (6) AND (7) ABOUT HERE

Once acknowledged the role of the different factors that should be accounted for to explore properly the effect of export activity on innovation strategies I can investigate specifically the role of the technological learning and demand effect on the different strategies implemented by firms. The underlying hypothesis is that the positive coefficient found for the export dummy in Table (4) is sometimes due to the technological learning effect and sometimes to the demand effect, according to the specific innovative strategy considered. In table (5) I substitute the export dummy with the two effects in the efficiency strategy specification. In column (1) and (2) I present the results

obtained with a simple OLS: when I only introduce the structural controls such as size, belonging to a group and those related with innovation capacity (R&D, skilled labor force, ICT) I find that both the technological learning and the demand indexes have a positive and significant effect. However when I introduce the additional controls for internationalization activity and vertical integration I find that only the demand effect is still significant. In columns (3) and (4) I use the instrumental variable (IV) strategy explained in section 3.4 and show the results obtained with a Two-Stage Least Squares (2SLS) estimator. The results of the IV estimation show that when I account for the possible endogeneity of the two effects only the demand effect is positive and strongly significant and the size of its coefficient increases when I introduce also the internationalization and vertical integration controls in the IV specification. The first-stage F-statistics of the two instrumented variables, reported in the lower part of Table (5), are slightly greater than 10, that is above the usual threshold identified by the weak instruments literature (Bound et al., 1995, see also Table 8 for first-stage regressions). Moreover the Hansen test on over-identifying restrictions shows that the instruments are exogenous to the error term and correctly excluded from the regression.

In Table (6) the technological learning and demand effects are introduced in the imitation strategy specification. In column (1) and (2) the results of the OLS estimation are displayed using respectively only structural and innovation-capacity controls in the first case and all controls the second: in both specifications only the demand effect shows a positive and significant coefficient. In columns (3) and (4) the results of the 2SLS estimation show that indeed only the demand effect is positive and significant, although the size and significance of the coefficient is lower than in the efficiency strategy specification and it decreases when I include also the internationalization and vertical integration controls. Again the Hansen test shows that the chosen instruments are valid and exogenous with respect to the error term.

In Table (7) I test the role of the technological learning and demand effect in the innovation strategy specification. In columns (1) and (2), in which OLS results are displayed, both effects show positive and significant coefficients, also when I include all the controls in the model. However when I adopt the IV approach I find that only the technological learning effect is still positive and significant, while the demand effect is no longer significant.

Summing up the OLS results of table (4), in which the export dummy is used, show that exporting activity indeed increases the likelihood of introducing each of the three identified innovation strategies: moreover the results show that it is important to distinguish between export and internationalization/vertical integration factors, in order to avoid the risks of overestimating the effect of export on innovation. In table (5), (6) and (7) it is found that the positive effect of export activities on the different innovation strategies is the result of different effects of the technological learning and demand effects: more specifically the demand effect increases the probability to introduce efficiency and imitative innovation strategies, while the technological learning effect only has an impact on the probability to introduce truly innovative strategies.

6. Conclusions

In this paper I analyzed the effect of export activity on innovation among European firms through the identification of two main effects -the technological learning and the demand effect- which are able to explain the positive effect of export activities found in the literature. In the paper I showed that the technological learning effect affects firms' strategies because it provides knowledge spillovers from foreign customers, suppliers or competitors in very technologically advanced markets: this is likely to reduce the internal research costs needed to develop new innovations. On the contrary the demand effect of exporting activities affects firms' strategies by increasing the potential output (units sold) of a firm. Market destinations with different combinations of these two effects will then provide also different incentives to innovate for firms. Indeed the technological learning effect has a positive effect on the introduction of brand new product innovations, in which research costs are very high, on the contrary the demand effect of exporting activity will mainly induce innovation strategies directed towards efficiency (which mainly consist of process innovations) and imitation of existing products, since these strategies are very sensitive to the increase of the number of unit sold. It must be stressed that while all types of innovation strategies can have a positive impact on firms' performances, in advanced economies research-based product innovations -able to actually shift the world technological frontier- are those with the highest economic impact (Acemoglu, Aghion, Zilibotti, 2006) and also at the firm-level they are likely to have a greater effect on total factor productivity growth (Duguet, 2006).

The policy implications of these results are important especially considering the European countries analyzed: not only it is found that exporting activity induces further innovation, but also that different types of destination markets might have different effects on innovation strategies. For example in a country in which firms export only to high growth markets with little levels of technological development firms might be induced to innovate only to increase efficiency and adoption, without putting enough efforts to develop truly innovative products. This strategy might be considered a typical "development trap" (Acemoglu, Aghion, Zilibotti, 2006) according to which an economy is never able to approach and shift the technological frontier and always remains a laggard country. The country patterns investigated in the descriptive statistics of this paper show that even after controlling for firms' size and for sectoral affiliation German firms that export have higher levels of the index that measures the technological learning effect with respect to the other European countries, and especially with respect to Italy and Spain. These features suggest that in southern European countries like Italy and Spain firms might lack an important incentive to introduce research-based product innovations that are able to increase their future innovative capacities and induce catch up processes within the European Union.

7. References

Accetturo A., M. Bugamelli, A. R. Lamorgese and A. Linarello (2014), Innovation and trade. Evidence from Italian manufacturing, *mimeo.*

Acemoglu, D, P. Aghion and F. Zilibotti (2006), Distance to frontier, selection, and economic growth, *Journal of the European Economic Association*, 4, 37-74.

Altomonte, C., T. Aquilante, G. Békés and G. I.P. Ottaviano (2013), Internationalization and innovation of firms: evidence and policy, *Economic Policy*, 28(76), 663-700.

Altomonte, C. and T. Aquilante, (2012), The EU-EFIGE/Bruegel-Unicredit Dataset, *Bruegel Working Paper*, October 2012.

Becker, S. and P. H. Egger, (2009), Endogenous Product versus Process Innovation and a Firm's Propensity to Export, *Empirical Economics*, 44(1), 329-354.

Bogliacino, F., and M. Pianta, (2011), Engines of growth. Innovation and productivity in industry groups, *Structural Change and Economic Dynamics*, vol. 22(1), 41-53.

Bound, J., Jaeger, D., and Baker, R. (1995), Problems with instrumental variables estimation when the correlation between instruments and the endogenous explanatory variables is weak, *Journal of American Statistical Association*, 90, 430, 443-450.

Bratti, M. and G. Felice, (2012), Are Exporters More Likely to Introduce Product Innovations? *The World Economy*, 35(11), 1559–1598.

Bratti, M. and G. Felice, (2012B), Buyer-supplier relationships, internationalisation and product innovation, *Development Working Papers 327, Centro Studi Luca d'Agliano.*

Bustos, P. (2011), Trade Liberalization, Exports and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinean Firms, *American Economic Review*, 101, 1, 304–40.

Canofari, P. Esposito, P., Messori, M. and C. Milani, (2014), *European Macroeconomic imbalances and policy adjustments*, IAI, Rome.

Chen, R., G. M. Milesi-Ferretti and T. Tressel (2013), External imbalances in the Eurozone, *Economic Policy*, January, 101–142

Cohen, A. M., J. Eliasberg and T.H. Ho (1996), New Product Development: The Performance and Time-to- Market Tradeoff, *Management Science*, 42, 2, 173-186.

Cohen, W. M., Klepper, S., (1996) Firm Size and the Nature of Innovation within Industries: The Case of Process and Product R&D, *The Review of Economics and Statistics*, Vol. 78 (2), 232-243.

Crespi, G., Criscuolo, C., and 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. and P. Epifani, (2012), Productivity, Quality and Export Behaviour, *Economic Journal*, 122 (565), 1206-1243.

Damijan, J. P., C. Kostevc and S. Polanec (2010), From Innovation to Exporting or Vice Versa? *The World Economy*, 33, 3, 374–98.

De Loecker, J. (2007), Do exports generate higher productivity? Evidence from Slovenia, *Journal of International Economics*, 73(1),69-98.

Desmet, K. and S. L. Parente (2010), Bigger is better: market size, demand elasticity, and innovation, *International Economic Review*, 51, 2, 319-333.

Duguet, E. (2006), Innovation height, spillovers and TFP growth at the firm level: evidence from French manufacturing, *Economics of Innovation and New Technology*, 15, 415-442.

Fafchamps, M., S. El Hamineb and A. Zeufackc (2008), Learning to Export: Evidence from Moroccan Manufacturing, *Journal of African Economies*, 17, 2, 305–55.

Gereffi G., J. Humphrey and T. Sturgeon (2005), The governance of global value chains, *Review of International Political Economy*, 12, 78-104.

International Monetary Fund, (2014), Euro Area Imbalances, *Annex to Umbrella Report for G-20 Mutual Assessment Process*.

Lileeva, A. and D. Trefler (2010), Improved Access to Foreign Markets Raises Plant-level Productivity . . . for Some Plants, *The Quarterly Journal of Economics*, 125, 3, 1051–99.

Liu, X. and T. Buck (2007), Innovation Performance and Channels for International Technology Spillovers: Evidence from Chinese High-tech Industries, *Research Policy*, 36, 3, 355–66.

Malerba, F., Nelson, R. R., Orsenigo, L. and S. G. Winter, (2007), Demand, innovation and the dynamics of market structure: the role of experimental users and diverse preferences, *Journal of Evolutionary Economics*, 17, 4, 371–99.

Mansfield, E., M. Schwartz and S. Wagner , (1981), Imitation Costs and Patents: An Empirical Study, *The Economic Journal*, 91, 364, 907-918.

Melitz, M. (2003), The Impact of Trade in Intra-industry Reallocations and Aggregate Industry Productivity, *Econometrica*, 71, 6, 1695–725.

Miravete, E.J., Pernías, J. C., (2006), Innovation Complementarity and Scale of Production, *Journal of Industrial Economics*, 54 (1), 1-29

Piva, M. and M. Vivarelli, (2007), Is demand-pulled innovation equally important in different groups of firms?, *Cambridge Journal of Economics*, 31, 691–710.

Roper, S. and J. H. Love (2002), Innovation and Export Performance: Evidence from the UK and German Manufacturing Plants, *Research Policy*, 31, 7, 1087–102.

Salomon, R. M. and B. Jin, (2010), Do leading or lagging firms learn more from exporting?, *Strategic Management Journal* **31,** 1088–1113.

Salomon, R. M. and J. M. Shaver (2005), Learning by Exporting: New Insights from Examining Firm Innovation, *Journal of Economics & Management Strategy*, 14, 2, 431–60.

Scherer, F., (1991) Changing perspectives on the firms size problem, in Acs, Z. J. and Audretsch, D. B. (eds), *Innovation and Technological Change. An International Comparison*, Harvester Wheatsheaf, New York.

Schmookler, J.(1954), *The level of inventive activity*, The Review of Economics and Statistics, vol. 36, pp. 183-190.

Schmookler, J. (1966), *Invention and Economic Growth*, Harvard University Press, Cambridge.

Verhoogen, E. (2008), Trade, Quality Upgrading and Wage Inequality in the Mexican Manufacturing Sector, *Quarterly Journal of Economics*, 123, 2, 489–530.

von Hippel, E. (1986), Lead users: a source of novel product concepts, *Management Science*, 32, 791–805.

Woerter, M. and S. Roper (2010) , Openness and innovation - Home and export demand effects on manufacturing innovation: Panel data evidence for Ireland and Switzerland, *Research Policy*, 39, 155–164.

Table 1. Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
Dependent variables				
Efficiency strategy	0.438	0.496	0	1
Imitation strategy	0.176	0.381	0	1
Innovative strategy	0.112	0.316	0	1
Independent variables				
Export				
Export in 2004	0.405	0.491	0	1
Demand effect	0.053	0.072	-0.365	0.455
Technological Learning effect	0.026	0.069	0	1
Structural variables				
employment(≤25)	0.470	0.499	0	1
employment(>25 and ≤50)	0.283	0.450	0	1
employment(>50 and ≤100)	0.110	0.313	0	1
employment(>100 and ≤150)	0.041	0.198	0	1
employment(>150 and ≤250)	0.033	0.179	0	1
employment(>250 and <500)	0.037	0.189	0	1
employment(≥500)	0.026	0.160	0	1
Share of fixed term contracts	26.773	38.902	0	100
Firm age (<6 years)	0.338	0.473	0	1
Firm age (6-20 years)	0.069	0.253	0	1
Firm age (>20 years)	0.593	0.491	0	1
National group	0.136	0.343	0	1
Foreign group	0.080	0.272	0	1
Family member as CEO	0.631	0.483	0	1
Innovative capacities				
Share of R&D	0.036	0.076	0	1
Skilled labor force	0.279	0.449	0	1
ICT access	0.914	0.281	0	1
Internationalization variables				
Foreign Direct Investments	0.049	0.216	0	1
Arms' length foreign production	0.040	0.196	0	1
Domestic affiliates	0.133	0.339	0	1
Foreign affiliates	0.074	0.262	0	1
Domestic competitors	0.855	0.352	0	1
Competitors in EU	0.430	0.495	0	1
Competitors in US	0.125	0.331	0	1
Competitors other geo areas	0.271	0.445	0	1
Vertical integration				
Vertical integration	0.233	0.235	0	1
Sales to order share (1-30%)	0.121	0.326	0	1
Sales to order share (30%-70%)	0.088	0.283	0	1
Sales to order share (>70%)	0.662	0.473	0	1

Domestic effects (sector level)				
Growth of domestic sector	0.095	0.103	-0.432	0.471
R&D intensity domestic sector	0.034	0.060	0.001	0.511
Total number of observations	12783			

Figure 1: The technological learning effect

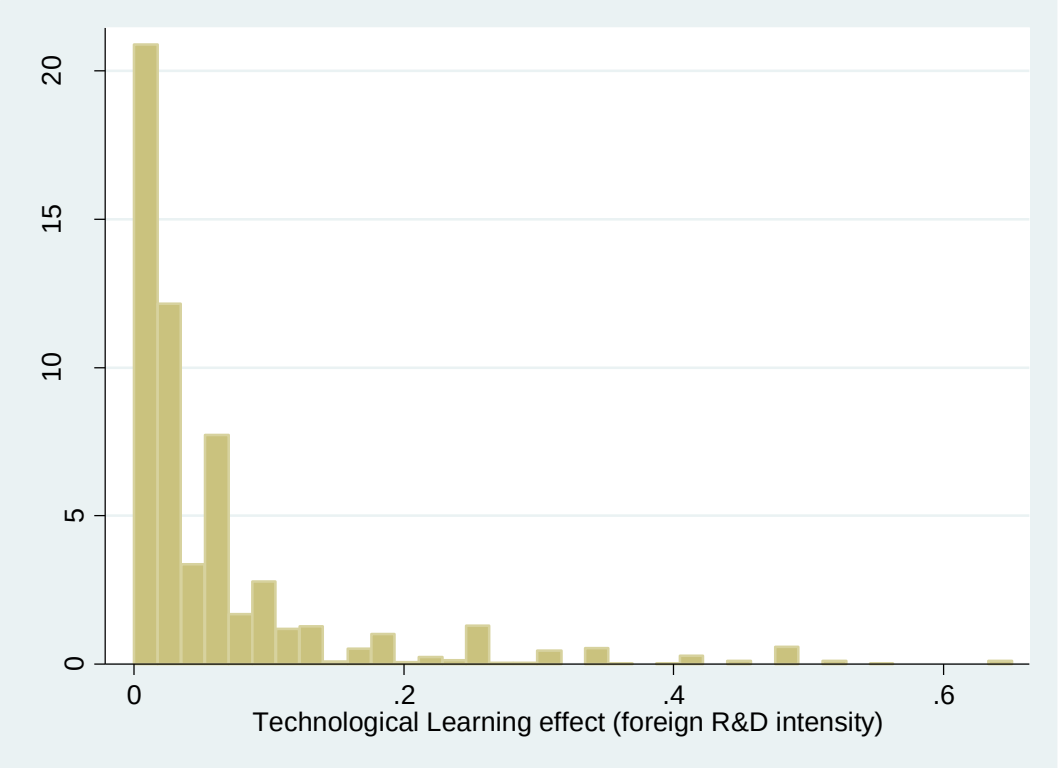

Figure 2: The demand effect

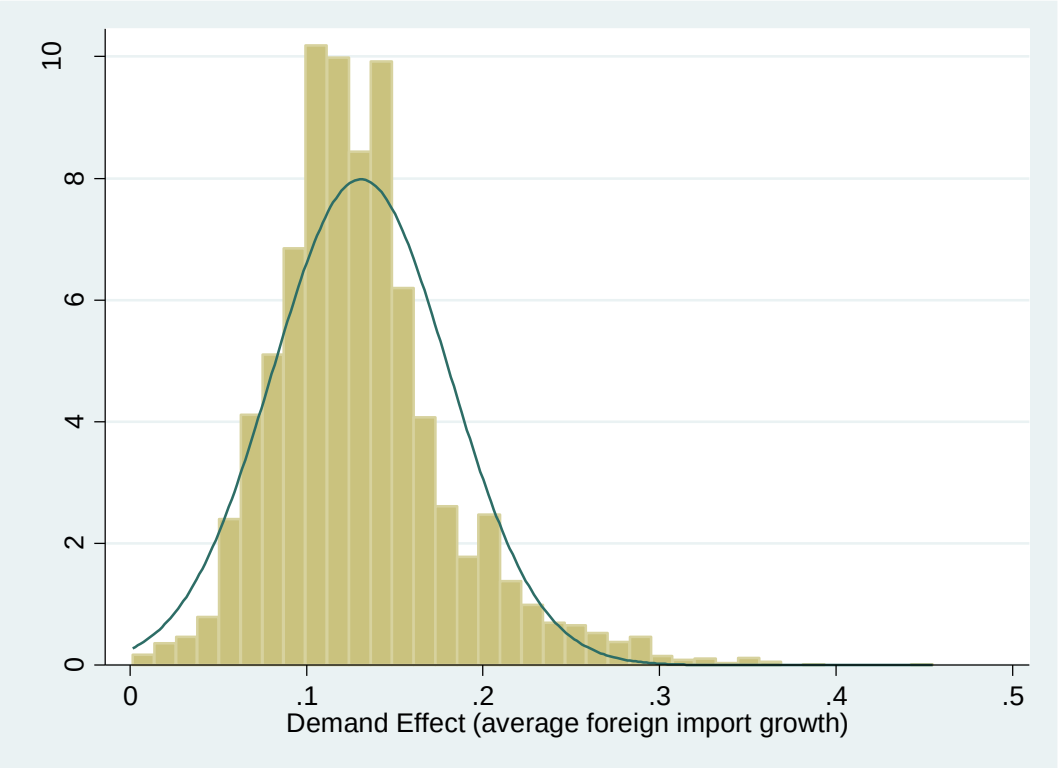

Table 2: Cross country differences in export and innovation strategies

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	export	export	efficiency strategy		imitation strategy		innovation strategy	
reference category: Germany								
France	-0.012	0.032**	-0.033**	-0.015	-0.062***	-0.047***	-0.036***	-0.009
	(0.013)	(0.013)	(0.013)	(0.013)	(0.010)	(0.010)	(0.009)	(0.008)
Italy	0.134***	0.171***	0.047***	0.084***	-0.058***	-0.050***	-0.013	0.019**
	(0.013)	(0.013)	(0.013)	(0.013)	(0.010)	(0.010)	(0.009)	(0.009)
Spain	0.001	0.065***	0.115***	0.151***	0.026**	0.028**	-0.047***	-0.003
	(0.013)	(0.013)	(0.013)	(0.013)	(0.011)	(0.011)	(0.008)	(0.008)
United Kingdom	0.076***	0.112***	0.064***	0.076***	-0.069***	-0.059***	-0.004	0.018*
	(0.015)	(0.015)	(0.015)	(0.015)	(0.011)	(0.011)	(0.010)	(0.010)
sector fixed effects	no	yes	no	yes	no	yes	no	yes
employment dummies	no	yes	no	yes	no	yes	no	yes
Constant	0.367***	0.051	0.401***	0.081	0.206***	0.101	0.133***	-0.109***
	(0.009)	(0.190)	(0.009)	(0.135)	(0.008)	(0.126)	(0.006)	(0.039)
Observations	12,783	12,783	12,783	12,783	12,783	12,783	12,783	12,783
R-squared	0.014	0.117	0.011	0.038	0.010	0.023	0.003	0.086

All models are estimated with normal Ordinary Least Squares estimator (OLS). Standard errors in parentheses are clustered at the firm level.

Table 3. Cross country differences in Technological Learning and Demand effects

	(1)	(2)	(3)	(4)
	Technological Learning effect		Demand effect	
reference category: Germany				
France	-0.005	-0.003	-0.006***	-0.005***
	(0.005)	(0.003)	(0.002)	(0.002)
Italy	-0.022***	-0.005**	0.000	0.003*
	(0.004)	(0.002)	(0.002)	(0.002)
Spain	-0.035***	-0.018***	-0.010***	-0.009***
	(0.004)	(0.002)	(0.002)	(0.002)
United Kingdom	0.010*	-0.004	-0.005*	-0.000
	(0.005)	(0.003)	(0.002)	(0.002)
sector fixed effects	no	yes	no	yes
employment dummies	no	yes	no	yes
Constant	0.076***	0.024***	0.134***	0.212***
	(0.003)	(0.008)	(0.002)	(0.017)
Observations	5,178	5,178	5,178	5,178
R-squared	0.028	0.600	0.006	0.393

All models are estimated with normal Ordinary Least Squares estimator (OLS). Standard errors in parentheses are clustered at the firm level.

Table 4. The effect of exports on innovation strategies

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	efficiency strategy			imitation strategy			innovation strategy		
Export	0.097***	0.054***	0.037***	0.038***	0.028***	0.020**	0.092***	0.052***	0.032***
	(0.009)	(0.010)	(0.010)	(0.007)	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
Share of R&D		0.900***	0.876***		0.078*	0.073		0.734***	0.673***
		(0.069)	(0.069)		(0.046)	(0.047)		(0.056)	(0.055)
ICT access		0.035**	0.029*		0.031***	0.031**		0.020**	0.014*
		(0.015)	(0.015)		(0.012)	(0.012)		(0.008)	(0.008)
Skilled labor force		0.047***	0.042***		0.012	0.010		0.035***	0.028***
		(0.010)	(0.010)		(0.008)	(0.008)		(0.007)	(0.006)
Share of fixed term contracts		-0.000	-0.000		0.000	0.000		-0.000	-0.000
		(0.000)	(0.000)		(0.000)	(0.000)		(0.000)	(0.000)
National group		0.009	0.003		-0.009	-0.011		0.010	-0.001
		(0.014)	(0.014)		(0.011)	(0.011)		(0.009)	(0.009)
Foreign group		0.005	-0.001		-0.002	-0.008		0.030**	0.018
		(0.018)	(0.019)		(0.014)	(0.015)		(0.014)	(0.014)
employment(>25 and ≤50)		0.075***	0.072***		0.027***	0.026***		0.027***	0.022***
		(0.010)	(0.010)		(0.008)	(0.008)		(0.006)	(0.006)
employment(>50 and ≤100)		0.122***	0.115***		0.036***	0.034***		0.074***	0.056***
		(0.015)	(0.015)		(0.012)	(0.012)		(0.010)	(0.010)
employment(>100 and ≤150)		0.156***	0.142***		0.054***	0.048**		0.132***	0.101***
		(0.023)	(0.024)		(0.019)	(0.019)		(0.018)	(0.018)
employment(>150 and ≤250)		0.215***	0.200***		0.050**	0.045**		0.180***	0.140***
		(0.025)	(0.026)		(0.021)	(0.022)		(0.022)	(0.021)
employment(>250 and <500)		0.175***	0.160***		0.042**	0.036*		0.156***	0.102***
		(0.025)	(0.025)		(0.021)	(0.021)		(0.020)	(0.020)
employment(≥500)		0.202***	0.179***		0.003	-0.008		0.243***	0.149***
		(0.030)	(0.031)		(0.023)	(0.024)		(0.026)	(0.026)

Firm age (6-20 years)	-0.028	-0.025	-0.012	-0.012	-0.011	-0.011
	(0.018)	(0.018)	(0.014)	(0.014)	(0.011)	(0.011)
Firm age (>20 years)	-0.042**	-0.039**	-0.002	-0.005	-0.017	-0.021*
	(0.018)	(0.018)	(0.014)	(0.014)	(0.011)	(0.011)
Family member as CEO	0.023**	0.022**	0.017**	0.016**	0.003	0.004
	(0.010)	(0.010)	(0.008)	(0.008)	(0.006)	(0.006)
Domestic affiliates		0.018		-0.003		0.023**
		(0.014)		(0.011)		(0.010)
Foreign affiliates		0.004		0.010		0.120***
		(0.020)		(0.016)		(0.018)
Foreign Direct Investments		0.018		0.020		0.059***
		(0.023)		(0.019)		(0.021)
Arms' length foreign production		-0.019		0.005		0.073***
		(0.022)		(0.018)		(0.019)
Vertical integration		0.054***		0.003		0.031***
		(0.019)		(0.015)		(0.012)
Sales to order share (1-30%)		-0.016		0.042***		0.015
		(0.017)		(0.015)		(0.011)
Sales to order share (30%-70%)		-0.018		0.002		-0.001
		(0.019)		(0.016)		(0.012)
Sales to order share (>70%)		0.026*		-0.022*		-0.022**
		(0.014)		(0.012)		(0.009)
Domesitc competitors		0.031**		0.004		-0.032***
		(0.013)		(0.010)		(0.010)
Competitors in US		0.044***		-0.019*		0.063***
		(0.015)		(0.012)		(0.012)
Competitors in EU		0.055***		0.024***		0.009
		(0.010)		(0.008)		(0.007)
Competitors other geo areas		0.026**		0.027***		0.004
		(0.011)		(0.009)		(0.008)
Growth of domestic sector		0.060		0.039		0.053

			(0.076)			(0.059)			(0.050)
R&D intensity domestic sector			0.004**			-0.002			-0.000
			(0.002)			(0.001)			(0.001)
Constant	0.195	-0.010	-0.018	0.120	0.030	0.032	0.011	-0.185*	-0.124
	(0.170)	(0.205)	(0.215)	(0.143)	(0.172)	(0.176)	(0.050)	(0.094)	(0.097)
Observations	12,783	12,783	12,783	12,783	12,783	12,783	12,783	12,783	12,783
R-squared	0.038	0.073	0.081	0.033	0.036	0.041	0.072	0.137	0.164

All models are estimated with Ordinary Least Squares estimator (OLS). All models include country, sector and region fixed effects. The reference category for firms' size is less than 25 employees. The reference category for firms' age is less than 6 years. The reference category for sales to order share is zero. Standard errors in parentheses are clustered at the firm level *** p<0.01, ** p<0.05, * p<0.1

Table 5. Efficiency strategy

	(1)	(2)	(3)	(4)
		Efficiency strategy		
	OLS	OLS	IV	IV
Technological Learning effect	0.130*	0.101	0.510	0.885
	(0.078)	(0.079)	(0.682)	(0.693)
Demand effect	0.266***	0.166**	4.476***	4.731***
	(0.072)	(0.073)	(1.211)	(1.427)
Structural and innovative capacity controls	yes	yes	yes	yes
All controls	no	yes	no	yes
IV First-stage				
F-statistics				
Technological Learning effect			8.95	10.93
Demand effect			12.44	10.23
Num. of instruments			4	4
Hansen statistics			3.919	3.616
p-value			0.141	0.164
Observations	12,783	12,783	12,783	12,783
R-squared	0.072	0.080	-	-

All models include country, sector and region fixed effects. Columns (1) and (2) are estimated with an OLS estimator, columns (3) and (4) are estimated with a Two-Stage Least squares estimator. Standard errors in parentheses are clustered at the firm level *** p<0.01, ** p<0.05, * p<0.1

Table 6. Imitation strategy

	(1)	(2)	(3)	(4)
		Imitation strategy		
	OLS	OLS	IV	IV
Technological Learning effect	-0.045	-0.052	0.474	0.082
	(0.055)	(0.056)	(0.446)	(0.428)
Demand effect	0.194***	0.140**	1.539**	1.556*
	(0.057)	(0.058)	(0.766)	(0.883)
Structural and innovative capacity controls	yes	yes	yes	yes
All controls	no	yes	no	yes
IV First-stage				
F-statistics				
Technological Learning effect			8.95	10.93
Demand effect			12.44	10.23
Num. of instruments			4	4
Hansen statistics			2.426	2.333
p-value			0.297	0.311
Observations	12,783	12,783	12,783	12,783
R-squared	0.036	0.041	-	-

All models include country, sector and region fixed effects. Columns (1) and (2) are estimated with an OLS estimator, columns (3) and (4) are estimated with a Two-Stage Least squares estimator. Standard errors in parentheses are clustered at the firm level *** p<0.01, ** p<0.05, * p<0.1

Table 7. Innovation strategy

	(1)	(2)	(3)	(4)
	Innovation strategy			
	OLS	OLS	IV	IV
Technological Learning effect	0.282***	0.224***	1.419***	1.077**
	(0.065)	(0.066)	(0.465)	(0.427)
Demand effect	0.269***	0.158***	0.706	0.341
	(0.050)	(0.051)	(0.634)	(0.692)
Structural and innovative capacity controls	yes	yes	yes	yes
All controls	no	yes	no	yes
IV First-stage				
F-statistics				
Technological Learning effect			8.95	10.93
Demand effect			12.44	10.23
Num. of instruments			4	4
Hansen statistics			1.185	1.177
p-value			0.553	0.555
Observations	12,783	12,783	12,783	12,783
R-squared	0.140	0.166	-	-

All models include country, sector and region fixed effects. Columns (1) and (2) are estimated with an OLS estimator, columns (3) and (4) are estimated with a Two-Stage Least squares estimator. Standard errors in parentheses are clustered at the firm level *** p<0.01, ** p<0.05, * p<0.1

Table 8. First-stage statistics

First stage	(1)	(2)	(3)	(4)
	Technological Learning effect		Demand effect	
T_1	1.073***	1.365***	-0.280***	-0.205*
	(0.263)	(0.271)	(0.102)	(0.116)
T_1*emp≤15	-0.810***	-0.788***	0.204**	0.226***
	(0.198)	(0.196)	(0.080)	(0.078)
T_2	0.283	0.301	0.991***	0.893***
	(0.198)	(0.190)	(0.217)	(0.212)
T_2*emp≤15	0.103**	0.114**	-0.225***	-0.195***
	(0.050)	(0.050)	(0.046)	(0.045)
Structural and innovative capacity controls	yes	yes	yes	yes
All controls	no	yes	no	yes
F-statistics	8.95	10.93	12.44	10.23
Observations	12,783	12,783	12,783	12,783

This table reports the first stage statistics for the instruments used in the IV Two Stages Least Squares Estimator (see section 3.1 for details).