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Firm performances, international activities and innovation. A micro level analysis on Italian firms.

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“If you have the talent, then will, ambition and the determination to expose yourself to new thoughts, counterargument, new influences, will strengthen and fortify your work, driving you closer to home.”

- Bruce Springsteen (Born to run)

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INTRODUCTION AND MAIN FINDINGS

The aim of this dissertation is to contribute to the debate on the relationship between innovation and internationalization. After providing in Chapter 1 a comprehensive overview of the theoretical and empirical debate on this relationship, we investigate in chapter 2 the impact of being involved in international market on innovation disentangling different strategies of foreign activity in order to add empirical evidence to the branch of the literature on learning-to-innovate-by-internationalization (LIBI) (Chapter 2). Finally, in Chapter 3, we examine the role of persistency in both innovation and export activity to see if the long-lasting involvements ensure higher returns on productivity. We will go through these different steps using data on Italian manufacturing firms covering an eight year time-span (1998-2006).

Going more in detail, in Chapter 1 we go through the debate going on in the literature in recent decades analyzing the change in theoretical perspective from an industry level approach that was in the vogue up to the end of '90s, to the growing importance of firms' heterogeneity that has been introduced at start of the century. This change in perspective has been reflected in the empirical literature and we will see the different branches and the main contributions to them.

The contribution to the literature we want to give in Chapter 2 is not only focused on exports as in the majority of the works in this field (see for surveys Wagner 2007, 2012; and, for Italy, Gattai, 2015) but the novelty of our approach is to consider different level of involvements in international activities: export, FDI and outsourcing. Moreover, we measure the impact of these strategies on different kinds of innovation: first of all, we will see if and how each strategy influences innovation performance as a whole, then we distinguish between product and process innovation. Our estimation models have been carried out through complementary methodologies: starting, first of all, with probit estimation, then moving to propensity score matching estimation to cope with endogeneity issues, and finally also using Heckman correction to control for any selection bias due to unobservable. What comes out from our results is that: 1) both exports and FDIs have a positive impact on innovation and the latter strategy has also an higher impact on the probability of introducing innovation if we consider any type of innovation; 2) when we consider product innovation, exporting and investing abroad raise the probability of introducing such kind of innovation; 3) outsourcing, instead, shows positive and significant coefficient when we consider process innovation suggesting that firms contracting out to other partners some stages of the production may introduce some innovation to optimize the whole process.

Then, since destination of international activities may influence the outcome, we also distinguish countries of destination in three different classes (EU15, Industrialized non-European countries and non-industrialized non-European countries) and we find, that exporters and FDI makers have higher probability to introduce innovation if they undertake their activities in countries outside the Europe, but, in particular and somehow

surprisingly, exporting towards non-European and less developed countries raise the probability of introducing product innovation since firms have to face greater consumer heterogeneity in less-developed countries than in more developed ones, since Italian customers have more similar tastes to customers from developed countries so firms have to modify their products to meet foreign tastes.

In Chapter 3 we change our perspective considering both innovation and internationalization strategies jointly and changing the variable of interest analyzing how the persistence in innovation activity influences the performance of the firm (measured through the total factor productivity à la Levinsohn and Petrin) and if this relationship changes if firms export persistently or do not. Using OLS and then a two step system Arellano-Bond GMM, we at first consider the effects of these strategies separately, and then, we consider them jointly. What we find is that when we consider the strategies separately they do not seem to allow firms to gain productivity. Our estimation results are in favour of the hypotheses of learning-by-exporting and learning-by-doing: persistent innovation efforts must be associated with a permanent presence on foreign markets since firms that persistently innovate *and* persistently export have better results in terms of productivity than persistently exporting firms that do not innovate persistently and than firms that do not export persistently.


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INNOVATION AND INTERNATIONALIZATION: THEORETICAL BACKGROUND AND EMPIRICAL FINDINGS.

Chapter 1

1. Theoretical underpinnings, motivation and novelties.

In the critical process of creating new sources of growth for firms, two aspects can be crucial: innovation and internationalization.

On one hand, the importance of internationalization has always been acknowledged and studied by economic literature, as it has always been a central issue both from a more aggregate point of view - it can, indeed, be measured as the presence of countries in international markets by their shares of exports, imports and FDI - and from a firm's point of view, as the possibility to generate value through international operations and gain competitive advantage against competitors.

On the other hand, defined as the creation and diffusion of products, processes and methods, innovation can be identified as another critical element to generate growth at an aggregate level (meaning new industries, businesses and jobs) as well as competitive advantage at firms' level.

However, in spite of its relevance, innovation has not always been considered with the attention it deserves and only over the last three decades the economic literature has started to study the importance of innovation as a key issue to understand the competitiveness of nations, industries or firms.

The motivations why firms decide to undertake internationalizing (at first, exporting) or innovating have been studies by a whole range of theories. Even if, traditionally, economic literature has focused on other elements rather than innovation as key factors for firms' growth[1], also in the main strands of economic thought the importance of innovation started to establish its importance.

According to life-cycle theory, for example, firms go through different stages of internationalization, starting from exporting operations, to foreign investment by acquisition, greenfield investment or joint venturing. Exporting is an important and initially preferred strategy of internationalization because it involves lower levels of commitment and risk, compared to FDI, because firms do not have to deal with costs and complexities of setting foreign establishments.

Studying, then, the product life cycle and the firm's innovation process, Vernon(1966, 1979) argues that the process of internationalization is usually based on product innovation: firms, usually detecting opportunity on the home market, innovates generating a product that can be exported to markets with similar characteristics. In particular, SMEs cannot afford to innovate for global markets, so they start from home market, moving towards the possibility to expand their business in

[1] For example, the theories of long-run economic change usually focused on other elements, such as capital accumulation or working of markets without considering innovation.

similar foreign market, through exporting and, eventually, through FDI.

Also trade theory and growth theory analyzed the relationship between innovation and export activity: the former branch of the literature has focused on the firm's ability to develop product and process innovations as one of the main factors that influence the decisions of exporting. According to New-Endowment trade models, for example, the decision to enter international trade or to invest in foreign countries (FDI) is associated to different stages of the product life-cycle and, in particular, Krugman (1979) argues that innovative products are more likely to be produced and exported by developed countries and when the products became mature, they are produced and exported by less developed countries.

The growth theory, instead, through the endogenous growth models, (e.g. Romer, 1990; Grossman and Helpman, 1991) suggests that the exporting activity can boost the innovation because of the stronger competition exporters are involved in, of the need to meet the demand of foreign customers with different preferences or the possibility to benefit technological spillovers from foreign markets.

More recently, the literature - in an attempt to explain that the drivers of internationalization/innovation process may be different from one firm to another - acknowledged that there is a relationship between these two two non-mutually exclusive aspects (from export to innovation, e.g. Salomon and Shaver, 1995; viceversa from innovation to entering foreign markets, Cassiman and Golovko, 2011).

The bunch of works related to this field has succeeded in explaining that there is a branch of research that highlighted the importance of exporting in enhancing the productivity of the firms and decision to innovate (Griliches 1979; Bernard and

Jensen 1995; Bernard and Wagner 1997; Clerides 1998) and, on the other side, that innovation[2] has a positive impact on the propensity to internationalize (specifically to export) (Bernard and Jensen 1995; Greenaway and Kneller 2007; Wagner 2007; Bellone et al. 2010).

Because of advancing research, the literature, has tried then to identify any possible causal relation between these two dimensions finding, on one hand, that a successful innovation can lead up to a *self-selection mechanism* - according to which only the most productive firms' can afford the decision to start exporting (*learning-to-export, anticipation effect or conscious self-selection*) - and on the other hand, firms can decide to face the costs of entering foreign markets acquiring knowledge and skills not available in the domestic market and then enhancing the domestic production too (*learning-by-exporting*).

In this scenario, the most important element has been the growing interest from a more 'sectoral view' to an analysis of firm-level that has unveiled how a large heterogeneity influences the competitiveness of firms within the very same industry. In this respect, firms' own peculiarities play a key role in determining the success of an undertaking and the main point is to identify what are these peculiarities.

By reading the literature related to this field, some gaps have jumped out at us and, more specifically, there are some aspects on Italian firms that haven't been addressed properly and so the contribution of this work lies in several directions.

[2] According to Schumpeter, innovations can be classified in five different types: "product technology innovation", "production process technology innovation", new sources of supply, exploitation of new markets and new ways to organize business.

First of all, in our approach, the central role of firm's heterogeneity is accounted for (in both Chapter 2 and Chapter 3) to provide a much broader overview on the links between firms' foreign exposure and their economic outcomes. The importance of firms' specific characteristics, as we will see in following paragraphs, has been stressed by the literature and we consider it in all the multifaceted nature of foreign transactions. Moreover, most of the literature has primarily focused on export as initially preferred strategies and, if we consider the Italian case (see Gattai, 2015 for a survey) most of the works focus on trade, without considering other strategies. In our work, we consider different internationalization strategies: export, FDI and outsourcing. While export/import premiums have been largely covered by literature, FDI and outsourcing have received less attention. If in international economic literature there are studies finding that different patterns of internationalization strategies imply differences in firms performance (e.g. Aw et al. 1998; Lööf et al. 2014; Damijan et al. 2015), this topic is completely unexplored for Italy.

Moreover, in most of the works in this literature, firms' performance has been measured through productivity. In our work, and in particular in the second chapter, we consider the impact of different strategies (also accounting for heterogeneity) adopting an uncommon measure of firms' performance in literature on Italy: innovation (we also differentiate the object of innovation: product and process).

The investigation of the LIBE hypothesis has been poorly covered for Italian firms. One of the most recent works in this field is the one by Bratti and Felice (2012), from which we distinguish through some novelties: first of all, we consider a longer time span because the authors consider the 8th (1998-2000) and the 9th (2001-2003) waves of the SIMF by UniCredit-

Capitalia, while we matched these two waves with the 10th, covering an eight-year period (1998-2006). Moreover, in our estimation procedure, we will cope with endogeneity issues not only trying to use instrumental variables as the authors do, but also trying to adopt other techniques (e.g. multivariate analysis of the determinants of firm performance based on panel econometrics and lagged variables methodologies; propensity score matching in Chapter 2; GMM, as in Salomon and Shaver, 2005 in Chapter 3).

From the analysis of our estimation results, we also try to contemplate whether a sort of pecking order in internationalization strategies (exports, FDI, outsourcing) could be hypothesized, based on their impact on innovation, due to learning spillovers.

Another original purpose we want to achieve is to understand, as far as our data allow, if the geographical destination of these activities may have some effects on the innovation performance. We do it by adopting a rough classification of host countries and, in particular, we look if there is a predictable results - confirming if the export/FDI/outsourcing activity towards more technology - demanding markets might spur the firm's innovation activity- or if there can be an unexpected gain in internationalizing in less-advanced countries.

This approach of dissecting different internationalization strategies by destination has been explored by few papers for Italy (e.g. Serti and Tomasi, 2008; Castellani et al., 2010; Lo Turco and Maggioni, 2012; Aristei and Franco, 2014) and always regarding export/import premia.

As said, one of the novelty of our approach is to consider different strategies of internationalization and, also in the case of destination, we consider FDI and outsourcing besides trade - Gattai (2015) highlights that "FDI has not been dissected yet

by geographical area" - trying to catch more details regarding each status.

Furthermore, we differentiate from previous Italian literature because we develop our empirical strategy applying an original technique. Usually, indeed, most of the studies in this field use OLS and discrete-dependent variable models to study the links between internationalisation and performance (Gattai, 2015).

Nevertheless, since we account for firms' heterogeneity and we want to provide evidence for causality, (in the second chapter) we implement the propensity score matching that has been applied in only in three papers (Conti et al., 2013; Crinò, 2010; Morone et al., 2011) and only to study trade premiums. Hence, we extend our empirical framework to the case of FDI and outsourcing strategies profit by the information richness of our database.

In Chapter 3, we started from the assumption that firms' performances can differ according to various (time-related) innovation and internationalization strategies pursued. Firms observed during a period, can start, continue or stop a strategy (both regarding innovation than internationalization) and so the effect of these decisions can lead to differences in productivity. If we consider these strategy jointly, performance differences (due to learning by exporting) can be explained by differences in the persistence of firms' innovation and exporting strategies. According to some recent works (Lööf, 2014), indeed, one of the possible explanations regarding the weak empirical support for learning-by-exporting is the level of engagement in innovation of exporters since they must have sufficient absorptive capacity in order to learn efficiently from their international market(s).

For these reasons, firms performances can differ according to various innovation strategies pursued (starting, continuing to

innovate during the whole period we consider, stopping or doing no innovation at all) and to different exporting persistency. Therefore, we examine the combined effect of exports, innovation and external knowledge on total factor productivity growth among manufacturing firms. We distinguish between frequent and temporary exporters as well as between frequent and temporary innovators.

To our purposes, we consider firm level data on Italian firms drawn from the AIDA Capitalia Survey of Manufacturing firms (Indagine sulle imprese manifatturiere) [3]. The information contained in the dataset concern several aspects of the activity of the firm that can be useful for our work (business and balance sheet data, employment, R&D activity, internationalization, management composition) and we use different designs of these data: in Chapter 2, we will use an unbalanced dataset drawn from merging three waves of the Survey (1998-2000; 2001-2003; 2004-2006); in Chapter 3, instead, starting from a balanced configuration of the dataset, we split it into two different datasets: one with only persistent exporters and another one with firms that do not export persistently. In each chapter there is a description of the dataset used.

The implications in terms of policy of our study are important. If a feature of Italy is that both the self-selection and the learning-by-internationalisation hypothesis are supported this greatly increases the set of available policy instruments. The second fact relates to the actors to which policy intervention could eventually be targeted. As stressed in Mayer and Ottaviano (2008), trade is a matter of firms rather than countries, i.e., aggregated country-level volumes of import,

[3] The institutes providing Capitalia-Unicredit data are AIDA and Centrale dei Bilanci.

export, FDI etc. are the result of disaggregated firm-level contributions. Hence, specific forms of intervention should be targeted to firms, not designed at the industry or country level. However, it is evident that firms' heterogeneity is extremely challenging from a policy perspective; if properly treated, it allows for successful implementation of targeted programs. However, any mistake in identifying the right target could translate into a waste of money.

The chapter is organized as follows: in the next session, there is an updated and comprehensive review of the literature, theoretical and empirical; section 3 is about the data used and the methodology followed to merge the different dataset we started from.

2. Traditional hypotheses and common findings.

The study of the relationship between technical change, and thus innovation, and internationalization dates back to early nineties and innovation, in all its aspects (e.g. channels of diffusion, measures, etc.) has been largely investigated by academics with different approaches and different findings.
Nowadays, as said, to understand this relationship is important both from the point of view of a policymaker - to determine how technology can diffuse between countries and to understand how some less-developed countries can catch-up to rich countries in the long run, in order to implement appropriate

policies - and from the managers' point of view to benefit from it taking the right strategical decisions.

In explaining how causality (if any) could run between internationalization and innovation, the literature has passed through several stages.

Since Ricardo (1817), indeed, the idea that there is a strong link between cross-country differences in technology and trade has been accepted and then proved through theoretical models and empirical results. Even if the author referred to the comparative advantage of a country actually meaning the labour productivity, for the first time he noticed that different levels of labour productivity may determine different patterns of specialization and trade.

The international economic literature has substantially focused on the effects that internationalization can have on the firms productivity documenting this relation following the two different paths already mentioned: on one hand, the previously mentioned self-selection mechanisms of more productive firms into export market based on the hypotheses that there are more additional costs in selling goods on foreign markets (transportation costs, distribution and marketing costs, production costs to adapt current domestic products for foreign consumers, etc.) and only more productive firms can face this sunk costs associated with fiercer competition in international market; on the other hand, the learning-by-exporting (LBE) hypothesis which considers that firms may learn from foreign contacts accessing to knowledge and skills not available in the domestic market and thus achieving productivity gains (Aw et al. 2011).

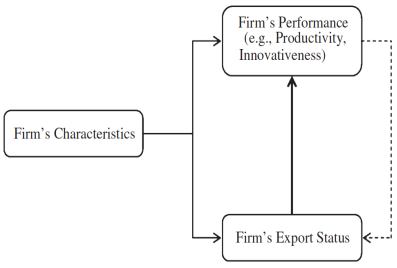
The literature has largely focused on the first hypotheses, theoretically (Melitz 2003, Constantini Melitz 2007) and empirically (Bernard and Jensen 1999; Clerides et al.1998; Aw et

al. 2000; Greenway and Kneller 2007), whereas the LBE has remained an under-explored topic with few relevant contributions supporting this hypothesis (Salomon and Shaver 2005; Wagner 2007, 2012, 2015; Crespi et al. 2008; Silva et al., 2010; Van Beveren and Vandenbussche, 2010; Bratti and Felice, 2012; Damijan et al., 2015).

The most relevant issue behind both hypotheses is that firms are substantially heterogeneous in terms of productivity and these differences influence both ex-ante, before entering foreign market and justifying the self-selection, and ex-post performance, meaning the way they assimilate the knowledge coming from foreign markets.

The Figure 1, by Bratti and Felice (2012), shows how firm's specific characteristics may induce potential positive association between firm's performance, for instance, in terms of productivity or innovativeness and its export status. We can notice that firm's specific characteristics may influence both its

Figure 1 - Sources of association between Export Status and Firm's Performance (Bratti and Felice, 2012)



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

innovation performance and its export status (solid arrows). If these firm's characteristics are observable and we are able to control for all of them, the positive correlation between export status and innovative performance should disappear. However it could be the case that the correlation survives and this may be due to some unobservable characteristics or to a pure causal effect of exports status on innovation (bold arrow) or to a reverse one (shown by the dashed arrow).

The economic literature questioned what are the sources of productivity differences, or of firms' absorptive capacity of knowledge spillovers, and, in particular, what are the peculiarities that influence positively firms' activity in general, and one of these can be found in R&D and innovation investments (see Griliches, 1998), pointing out that these are important elements to explain ex-ante productivity differences and ex-post assimilation process of knowledge.

In the next sessions, we will describe in more detail the theoretical models, and then the empirical results and achievements of the literature.

2.1 Theoretical Literature: From an Industry Level Approach to Firms' Heterogeneity.

From a theoretical perspective, the traditional economic models were not able to consider the inter-firm differences to explain the export behaviour and to give formal explanation to the self-selection mechanism and learning-by-exporting hypotheses.

The evolution of the theoretical literature has been characterized by a progressive shift from an aggregate level of analysis to a more micro level analysis and only in more recent works authors started to acknowledged firms' specific characteristics the central role they have including them in the analytical formulation.

Traditionally, indeed, the economic theory has analyzed the relationship between innovation and exporting activity from an industry level point of view[4], assuming that all the firms in a particular country are symmetrical, facing the same demand and using the same technology, without considering the differences between the firms. In the "new trade theory" framework (see, for example, Krugman 1979) all firms that decide to export are supposed to produce a unique product variety and firms don't face any fixed cost of exporting.

Starting from more recent works (Baldwin 1989; Dixit 1989) models have considered fixed sunk costs to enter into export markets due to barriers and incomplete information costs, uncertainty about contracts and difficulties in the establishment of distribution channels.

Clerides et al. (1998) were one of the first to consider a model in which only firms with lower marginal costs earn sufficiently high gross profits from producing to cover the sunk cost of entering foreign markets. According to their framework not all firms export, leading to the conclusion that self-selection is fundamental: firms have to raise productivity before they enter confirming the connection between productivity and exporting.

[4] Trade models focusing on firms' capacity to introduce new products or process in order to explain the internationalization choices of the firm; or growth models, that tried to explain the competitive advantage of firms associate to different endowments of factors.

The authors also raise the possibility of learning-by-exporting: their intuition is that, once a firm has entered export markets, it may generate efficiency gains and productivity growth may receive a further boost. Moreover, they also consider that the presence of exporters in a certain region might generate positive externalities for firms of the same region that can enter in foreign markets easier or less costly because of this positive effect.

However, the cornerstone of the theoretical literature is the work by Melitz (2003) who focuses the attention on the inter-firm reallocation and industry productivity considering the presence of a large heterogeneity and of a selection mechanism in terms of extensive margin (participation) and intensive margin (the level of sales abroad with respect to total sales).

In his landmark work, the author developed a dynamic general equilibrium (Dixit-Stiglitz) model in which heterogenous firms operate in monopolistically competitive industries. His work shows how the exposure to trade induces the more productive firms to become exporters - while some less productive continue producing for domestic market - forcing the less productive to cease production and to exit the market with endogenously determined productivity threshold[5].

The starting assumption of his work is that there exist some sunk costs (transportation, new distribution channels) for the firms to sell in international market and only firms that surpass a threshold level of productivity can make positive profits and decide to enter foreign markets.

The one by Melitz is not the only model considering the causal relation between productivity and exporting: Bernard, Eaton et

[5] See Appendix 1 on how Melitz determines the productivity threshold.

al. (2003), using a different industrial organization structure, still explain that competition on foreign markets boosts the plant productivity and Helpman et al. (2004) introduced the possibility for firms to sell directly to the host country (horizontal FDI) only if they are the most productive, whereas the intermediate productivity firms enter exporting market and low productivity firms serve the domestic market.

However, all these theories do not seem to explain any causal relation between firms decisions in investment in innovation and the decision to export. An exception may be Costantini and Melitz (2008) who build a dynamic model, in the context of liberalization of trade regimes, capturing the self-selection of more productive firms into export markets. Starting from the assumption that the export market participation and innovation decisions of firms are jointly considered, they try to solve some potentially conflicting results concerning the direction of causation between export participation and productivity (based on whether productivity improvements are observed ex-ante or ex-post after export market participation).

There is another stream of the literature that tried to consider endogenously some decisions taken jointly with foreign market participation: Yeaple (2005), for example, consider a general equilibrium trade model in which firms are homogeneous but only the ones that are able to face fixed costs associated with technology adoption are able to start exporting.

The decisions to innovate and to start exporting are jointly taken into account also in the Bustos (2011) model and also in this case the firms are heterogeneous: the less productive exit the market, the most productive decide to both innovate and export and the firms in the middle decide only to export or, the ones with lower productivity, to do neither.

Dynamic models of trade and innovation predicting that exporters will choose a higher innovation intensity with respect to non-exporters have been recently suggested, for example, by Aw et al. (2011) who develop and estimate a dynamic structural model of exporting and R&D that allows the self-selection of more productive firms into both exporting activity and R&D investments recognizing a direct effect of R&D and exporting on future productivity.

2.2 Empirical Literature: Does innovation spur firms' performance?

Since the theoretical literature changed the perspective of analysis from an industry level approach to the heterogeneity of the firms, it has made clear that firms' specific characteristics - in particular the ex-ante productivity, investments in R&D, capital- and labour-intensity, ownership, managerial capabilities - may affect the performance of the firm and then the benefits and costs of entering foreign markets.

The empirical literature, as well, has recognized that firms' characteristics may have different effects on productivity, innovation and degree of internationalization and it has started to study the different interrelations between all these aspects (Bernard and Jensen 1995; Greenaway & Kneller 2007; Wagner 2007, 2012; Caleb et al. 2015, to quote some).

A well-established stream of literature, for example, consider the productivity as the variable mainly useful to measure the effect of R&D investments and activities. This aspect is the most largely investigated and the results are broadly accepted. Starting from the paper by Griliches (1979) up to more recent studies

(e.g. Clerides 1998, Wagner 2006), it has been clear that R&D enhances firm's productivity but later studies have focused on whether the productivity gains are different across sectors (more or less technological intensive) and according to different grades of openness towards foreign markets.

Also in the empirical literature, the two hypotheses investigated regarding the positive correlation between export status and productivity are the self-selection and the LBE.

As previously underlined, the branch of research related to the self-selection mechanism hypothesis is based on the idea that firms that start exporting have to face some sunk and fixed costs (marketing, training, market research costs, licenses) and other costs due to the competition in a unknown market in order to align to foreign consumers' tastes or to respect the regulation of the country of destination. For these reasons, bigger and more productive firms are most likely able to afford these entry costs. The first most relevant article on this issue is the one by Bernard and Jensen (1995); they find that exporters are substantially different from they counterparts, even in the same industry or region. The authors, working on microeconomic data on US manufacturing firms in the 1976-1985 period, found evidence about the better performance of exporters with respect to non-exporters and examined the variables of plants that influence exporting. Exporters come out to be larger, more capital-intensive and with a higher labour-productive. However, the authors don't find a clear relation between the export status of the firms and their performance in the long run: dividing plants in different categories, according to their export status, they found that the ones that start exporting show better performance than the ones that do not change their status and, furthermore the ones who stop exporting show worst

performance values, confirming that good plants are exporters but with any prediction about the future performance.
In support of this conclusions are, also, the similar results that have been found by Bernard and Wagner (1997) analyzing data on German firms and the results by Clerides et. al (1998) who, starting from the self-selection mechanism hypothesis and considering data on some developing countries (Colombia, Mexico and Morocco), confirmed that exporting firms are more efficient than non-exporting ones but they investigated whether exporting implies productivity gains: do firms learn to be more productive by becoming exporters? The authors found a weak evidence to this causality finding more plausible that low-cost producers (producers showing a low cost function) find profitable to become exporters.[6]
There are some other works on self selection that have contributed to this stream of literature that have to be mentioned: Lefebvre et al. (1998), for example, find clear indication that export intensity on global markets is strongly related to a broad and diversified base of R&D capabilities. However the authors highlight how different foreign markets require specific R&D investments since the destination of exports modifies the set of determinants of firm's performance. Wagner (2006), using data on German firms, finds similar results confirming that firms operating on international markets have better performance in terms of productivity and produce more new knowledge.
The positive effect of innovation on the probability of participation in export markets has been found by many other

[6] For similar results see also Wagner et al. (2007). The authors found a causal relation between exporting and labour productivity growth, but only in some sub-intervals.

works (Caldera, 2010; Ganotakis and Love, 2009; Cassiman and Golovko, 2011; Van Beveren and Vandenbussche, 2010, Bravo-Ortega et al. 2013, to quote some).

For Italy several studies have also found evidence in favor of a positive effect on trade due to R&D expenditure and to product innovation, whilst process innovation seems to play a marginal role (Sterlacchini 2001, Basile 2001)

Aw et al. (2011), with empirical applications of their dynamic structural model, analyze the decision process from exporting and R&D investment of Taiwan's electronic producers finding evidence, also in this case, for a self selection of more productive plants in both activities and for the higher probability that plants that are already involved in either activity have to continue them than the new ones to begin exporting or doing R&D.

Whilst there is large evidence, based on more aggregate studies, supporting the notion that importing is associated with technology spillovers, e.g. Altomonte and Békés (2010) using Hungarian microdata demonstrate that importers are more productive than firms engaged in exports only, the learning-by-exporting hypothesis has become more popular in literature in the last decade. It originates from the idea that interacting with foreign agents (competitors and customers) provides some knowledge that is not available on domestic market (Wagner 2007). The results on LBE are not so unambiguous and are more mixed, given that results for post-entry differences in performance between export starters and non-exporters point to faster productivity growth for the former group in some studies only (Wagner, 2012).

According to the literature, operating on foreign markets has some positive effects, reducing costs and improving quality because of:

- new customer demands (Clerides et al. 1998)
- technological advance (Aw et al. 2007; Cassiman and Golovko 2011)
- the external economic environment forcing firms to improve investment in innovation in order to be more competitive (Salomon and Shaver 2005).

  Even if there is abundant evidence that exporters are more productive than non-exporters (Bernard and Jensen 1999; Clerides, Lach and Tybout 1998) and it has been emphasized that LBE is important, however the results found by the literature have been less robust.

  As said before, Clerides et al. (1998) tried to find evidence that entering into exporting boosts productivity, but they find weak results.

  Salomon and Shaver (2005), indeed, using a non-linear GMM approach with data on Spanish firms, find that firms increase their production, product innovation and patent application subsequent to becoming exporters and, moreover, less developed countries stand to gain more from trade than developed ones. Nevertheless, the authors find that the results are not uniform over all the sectors because there are some industry factors influencing them.

  More recently, similar results have been found by Bloom et al. (2016) who studied the impact of exports towards China on firms of 12 European countries looking for evidence for the trade-induced technological change hypothesis and finding a significant growth of patents, R&D and TFP, but a decrease in the employment especially in the less technological advanced sectors.

  Criscuolo et al. (2010), for example, find that globally engaged firms (exporters and multinationals) generate more knowledge,

not just because they use larger stocks in terms of researchers, but also because they have access to larger stocks of knowledge through contacts with foreign customers and suppliers; moreover, they find evidence that the source of knowledge has influence on the type of innovation (e.g. Universities are useful for patents; business contacts have positive effects on broader innovation measures).

Furthermore, in his work on Portuguese firms, Silva et al. (2012b) use the propensity score matching and the difference-in-difference estimation finding that learning effects are higher for new exporters that are also importers or start importing at the same time.

The positive effect of an increase of foreign trade on the propensity to innovate has been investigated recently by different authors: Accetturo et al. (2014) for Italian manufacturing firms; moreover, Damijan et al. (2015), when explore the learning effects of firms' participation in both importing and exporting through innovations, finding that both may have important beneficial effects on firm innovation. The authors argue that "a firm may learn through its international contacts and demand-supply linkages, which may in turn be reflected in its innovation efforts in terms of new products or new processes". This learning process, however, does not translate immediately into productivity boosts and could have an impact on productivity growth only in the long run.

They highlight that may be an exact sequence of firm's participation in trade and subsequent learning effects starting either by trading status (importing/exporting) or innovator status (product, process or joint product-process).

The results also indicate that smaller firms benefit from import links to learn production process and this may help them to get prepared for entering to foreign markets.

Some authors assert that studies may have failed to find evidence for LBE hypothesis because they do not consider important elements such as investments in technology made by firms to absorb and assimilate knowledge spillovers (Aw, Roberts and Winston 2005).

One of the aspects that has to be considered is the impact of firm's decision to invest in research and development and the related ability to introduce innovations.

Another important element that might affect the performance of firms is the strategy, in terms of internationalization or in terms of innovation.

Altomonte et al. (2013), indeed, study how the different internationalization strategies (outsourcing, exporting, FDI) are correlated with innovation. Using the EFIGE dataset, the authors find "strong positive correlation between innovation and internationalization at the firm level, robust across countries and sectors combined, controlling for firms size and productivity" and the strength of the correlation increases with the complexity of the internationalization strategy: it is higher for outsourcers and FDI makers than exporters, importers and outsourcers only.

While Mayer and Ottaviano (2007) argue that there is an elite group ("happy few") in which the two activities on internationalization and innovation are concentrated, Altomonte et al. (2013) find evidence that, even if large and more productive firms are the main drivers, also smaller and less productive firms can be active on foreign markets by choosing a mix of simple internationalization and innovation activities.

Another paper following the hypothesis that different strategies in internationalization can have positive effects on productivity only if firms undertake innovation investments is the one by Lööf et al. (2015).

The authors found that persistently innovating and persistently exporting firms grow faster than persistently exporters that switch from being innovator to not.
They distinguish different strategies of internationalization and innovation finding that a persistent engagement in innovation investments enhances capacity of firms to absorb the knowledge they acquire from international activities. This absorptive capacity is influenced also by the local and regional environment: the more knowledge-intensive the social milieu, the more the firms benefit from exporting.
Focusing on Italy, firm export performance has been investigated in many contributions, reflecting, also in this case, the changed perspective in explaining exporting performance from a industry level approach to a more firm specific one. A bunch of studies, consistently with the international literature, find evidence that non exporting firms turn out as the worse performers with respect to firms involved in international activities, characterized by both the highest productivity premiums and the highest R&D efforts and innovative performances (Sterlacchini, 2001; Brancati et al. 2015).
Basile (2001), for example, starts from the assumption that export behavior can be determined by different factors such as innovation activity (new products or cost saving technical processes), firms specific characteristics (labour cost per unit of product, firm size, ownership), industry and geographical localization. Analyzing and comparing the relationship between export behaviour and innovation capabilities of Italian firms, with particular attention on firms located in the south of Italy, the author find evidence that innovation is very crucial factor in explaining firm level heterogeneity in export behaviour.

Castellani and Zanfei (2007), even if the data they use[7] do not allow to explain if there is self-selection or post-entry learning and technological accumulation effects, uncover evidence that firms involved in international activities show high productivity premium and better innovative performance, especially if firms outsource manufacturing activities.

There are different studies about Italy trying to detect the relationship between firm's innovation activity and its probability to export, looking at different dimensions that may affect this relation: Nassimbeni (2001) finds that the propensity of small units to export is strictly linked to their ability to innovate the product and develop valid inter-organisational relations, while it is less related to the technological profile (e.g. quality control, manufacturing, management, design); Benfratello and Razzolini (2009), through the estimation of different measures of TFP, find that there is a productivity ranking among domestic firms, exporters and FDI performers with the latter showing the higher productivity; Frazzoni et al. (2012), for example, find some evidence that the strength of the bank-firm relation has a positive impact both on the decision to export and on the intensity of exports and significantly affects the probability that the firm introduces product innovation; moreover the work by Sterlacchini (2001) emphasizes that the firms' size must be considered to explain why some firms have more propensity to export than others; finally Benfratello et al. (2014), analyzing the characteristic that may have positive effect on firm performance, find that R&D expenditure affects export intensity.

[7] The authors use the CIS II by Eurostat and the ELIOS dataset, developed by the University of Urbino.

A different approach to the problem is the one by Castellani, Serti and Tomasi (2010) who studied both the exporting and the importing problems related to international firm activity. The authors, using data on firms' characteristics and economic performance combined with data on their exporting and importing activity, find evidence that importing can be as important as exporting as a source of firm heterogeneity and firms involved in both importing and exporting (two-way traders) are the best performers. However they also find that firms involved only in importing activities perform better than those involved only in exporting.

On the side of the learning-by-exporting framework, Bratti and Felice (2012) show that export status affects the propensity of firms to introduce innovations. They also find that there is some positive correlation between the level of innovation of a firm and some other observable factors (share of graduated workers, FDI, group membership, etc.).

Accetturo et al. (2014), first presenting a theoretical model with heterogeneous firms showing how an increase in foreign demand boosts firms incentives to innovate and introduce new products, find empirical evidence supporting the theoretical results since an expansion of foreign demand turns out to be an important driver for innovation and this effect is mainly driven by firms that have already innovated in the past.

In conclusion, the literature reviewed has underlined the importance of both innovation and internationalization activities as drivers for increasing firms production. The study of the relation between these two variables may have important implications for policy makers in order to implement more precise policies to encourage innovation and to stimulate exports.

3. Exploring causality: how does it work?

As we have already seen in the previous paragraph, traditionally the object of interest of economic literature has been to see how the firms' performance is influenced by their characteristics.
The positive ex-ante effect of innovation on the probability of participation in export (*from innovation to export*) markets has been found by many authors (Caldera, 2010; Ganotakis and Love, 2009; Cassiman and Golovko, 2011; Van Beveren and Vandenbussche, 2010, Bravo-Ortega et al. 2013, to quote some). In most of these studies, indeed, the authors find empirical evidence for a twofold effect that innovation might have on firms' performance: both by improving productivity levels, which can persuade firms to start exporting, and also, through investments in R&D, facilitating the assimilation of the benefits from export markets. So, from this evidence, it is possible to argue that exports and R&D are complementary to achieve better productivity performance and so to gain competitive advantages.
The role of innovation, however, is also crucial to estimate the other way the causal relation may work (*from export to innovation*). In particular, there is a minor branch of the aforementioned LBE, that we want to contribute to, measuring the impact of accessing to international markets on innovation itself: the learning-to-innovate-by-exporting (LIBE).
Traditionally, most of the studies about the impact of internationalization on firms' performance focus on productivity premia measured usually as labour productivity (value added per employee), or Total factor productivity (TFP), but what we are interested into, is if the participation to international markets spurs the innovation performance of

firms increasing the probability of introducing innovation and if this probability is increased by different internationalization strategies implemented or market served (Chapter 2). Besides, we study if the persistence in implementing this strategy increases the return in terms of productivity.

Aw et al. (2007) find that, if we do not consider the investments in R&D, the productivity of exporters is significantly higher than that of non-exporting firms. Moreover, firms that export and invest in R&D are found to have higher productivity than those that only export.

Finally, the recent literature has attempted to examine the existence of any *bidirectional causality between innovation and internationalization.* Aw et al. (2008), using a structural model of the firms' decision to invest in R&D, find that there is a process of self-selection of more productive plants driving firms' decision to participate in both activities.

Nevertheless, there are some studies finding that these effects are limited to a specific sample or cohort of firms: Damijan et al. (2010), through the application of a propensity score matching technique to classify firms according to their propensity either to innovate or to export, even though they do not find empirical evidence for LBE, they find that only medium-sized and large exporting firms increase their probability to introduce process innovation.

Lööf et al. (2015) examine how differences in innovation strategy among (permanently or temporary) exporting firms influence their total factor productivity growth and find that among firms that are permanently present in export markets, persistent innovators grow faster than firms that change their status between being an active and an inactive innovator. A similar pattern is found among non-persistent exporters, but the estimates are nonsignificant or only weakly significant. Similarly,

Love and Ganotakis (2013), investigating the learning-by-export hypothesis by examining the effect of exporting on the subsequent innovation performance of a sample of high-tech SMEs in the U.K., find that exporting helps firms to innovate subsequently, but only firms that are consistently exposed to export markets are able to overcome the innovation hurdle.
What we are interested in, and it is the aim of Chapter 3 of this dissertation, is to find evidence about the existence of any effect of undertaking jointly both strategies on firms performance. We will study if firms gain from being engaged in both activities with respect to firms that undertake just one of them separately.

4. Data

To our purpose, we consider firm level data on Italian firms drawn on three waves of a survey: from the 8th (1998-2000) and 9th (2001-2003) Capitalia Survey of Manufacturing firms (Indagine sulle imprese manifatturiere, SIMF or Capitalia Survey) managed by the Capitalia banking group (formerly Mediocredito Centrale and now member of the UniCredit Group) and on the X-Wave (2004-2006) of the Capitalia-UniCredit survey[8].
The data where gathered from a detailed questionnaire submitted by all companies customers of Capitalia, one of the

[8] The institutes providing Capitalia-Unicredit data were UniCredit (Mediocredito) and CERVED Centrale dei Bilanci. The data provided qualitative and quantitative information concerning several firms characteristics: ownership structure, workforce composition, internationalization and innovation activities.

largest Italian banks, with more than 10 employees and the survey is on samples for firms from 11 to 500 employees and a census for firms with more than 500 employees; the resulting sample is stratified according to size class, geographical area and industry Pavitt taxonomy classification, aiming to significantly represent the Italian manufacturing firms scenario[9].

The qualitative and quantitative information contained in the dataset concerns all the aspects of the activity of the firm: business and balance sheet data, employment, R&D activity, internationalization, management.

The variables contain information on different aspects: total sales, the distribution of the shares, the composition of the workforce, important information about the internationalization and the investments in innovation and financial information.

The dataset provides, in particular, useful information, for our analysis, on the activity of the firms and their interrelated strategy of internationalization and innovation allowing to distinguish the purely domestic ones from the exporters and the ones engaged in other forms of internationalization (off-shoring, indirect trade, agreement of collaboration, FDI, etc.). The variables on innovation follow closely the information contained in the Community Innovation Survey.

[9] The following selection bias of the Mediocredito dataset must be taken into account. More than 90 percent of observed small firms (below 50 employees) are "società di capitali" (entrepreneurs have limited liability) while in the universe of Italian small firms this share is much lower and unlimited liability is widespread. When interpreting empirical results we must therefore consider that we are analysing the subset of Italian small and medium sized firms with the most advanced form of corporate governance.

The surveys we use are repeated over time at three-years intervals and the panel design is stratified and rotating so in each wave a part of the sample is fixed over time while the other part is renewed in order to analyze both variations over time for the firms observed in different waves and the structural change of the Italian economy, for the part of the sample varying in each wave.

The data at our disposal were divided in three different datasets, one for each wave: one for the 8th for the 1998-2000 period with 4.680 observations; one for the 9th wave in which there were 4.289 firms observed for the years 2001-2003; and a third dataset for the 10th Wave (covering years 2004-2006). It is worth saying that in the 10th Wave of the survey, with 4.088 firms, the population has been partially resampled keeping 1.049 firms[10] from the 9th wave.

The variables collected in the each dataset come from the answers the firms have given to the questionnaires. Over the different waves of the survey, however, the questions have been maintained as much constant as possible, in order to make the data comparable over time. For this reason, the following description of the 10th wave survey (that is almost identical to the previous editions) will give a quite consistent picture of the different surveys.

The questions are in some cases dichotomous and in some others very detailed; sometimes they refer to the three-year period, but other times only to the last year observed.

The information has been collected through a questionnaire, submitted to the firms, made of 5 different sections. In the first section, there are questions on general information about the

[10] Source: UniCredit - "Decima indagine sulle imprese manifatturiere italiane" - Rapporto Corporate N.1, 2008.

firms: the main activity; if the firm in the period considered has carried-out demergers, acquisitions; the legal form; information about the ownership, such as how the shares are distributed, who controls over a sufficient percentage of the shares and if the firm is part of a corporate group or of a consortium.
The section B of the survey is about the composition of the working force of the firm. In addition to all the information about the educational qualifications of the employees, their nationality (more specifically, the percentage of foreign workers divided by tasks), and their placement in the organizational chart, the firms are asked to give information about the type of employment contracts they offer to workers (e.g. fixed-term contracts, contract of services, etc.).
The third section of the questionnaire is one of the most relevant for the purposes of this work, since it is about the investments carried-out by the firms to expand the business, in technology innovation, and R&D. In this section, some new questions about investments in IT (e.g. if the firm uses broadband, cable or wireless internet connection; which kind of services are accessed through internet) have been introduced with respect to the Wave IX and VIII in order to reflect the change in the use of technology by the firms. What is relevant for our work is that, in this section, there are several questions about innovative activities implemented: if the firms has introduced some innovations and what kind of innovation (process, product, organizational); moreover, there is a detailed question (C2.1.2) about the distribution of the total expenditure in R&D between different options: internal or external R&D; patent acquisitions; expenditure in machinery, plants and equipments; marketing and advertising of new products or processes. This question is detailed for the 2006 year, but for the previous two years we have a less detailed one (C2.2.1) in which

it is asked to indicate the total amount invested in internal and external R&D. The last questions are about the sources of both acquired R&D (for 2006) and of finance to invest in R&D (aggregated for the three years period).

Another relevant section for our survey is about internationalization of the firms. It is important to highlight that in this section, as in the previous one, there are some questions only regarding the last year (2006), and some others about the whole three-years period. From this section, we can draw information about if the firm has exported in 2006 and the percentage of the sales revenue by destination or if, in this year, the firm has pursued market penetration strategies and the related destinations; if in 2004-2006 period commercial agreements, patent acquisitions or sales have been achieved, also in this case, the information are provided by destinations. Moreover, firms have to indicate if they have outsourced or delocalized at least a part of their production process or if they have pursued FDIs and the amount of the latter, divided by country of destination, and if these FDIs have to provide products to be sold in the country where the production unit is located, semi-processed goods to be used in the internal production process, or final goods to be sold in foreign countries.

The last part of the section D (more specifically, the D4 section) provides information that can be interpreted as the import-side of the internationalization of the firms, since there are two questions: one is about the services and one about the tangible assets, both acquired by foreign countries and divided by country of origin.

The last two sections provide information about the market composition and competition (section E), and some financial information (section F). From the questions contained in

section E, we can know the channels of distribution of the firms, the percentage of production on job orders, and some information about the main competitors of the firms (location, size, type of competition). The last section is basically about the financial dimension of the firm: funding sources (project financing, venture capital, private equity, etc.); frequency of contacts with specific financial intermediaries; if the firm has produced audited accounts, and if there is the possibility to be listed in the following year.

Moreover, in the dataset, there are information on balance sheets of the firms (credits, debts, stocks, legal reserves of accumulated incomes, etc.) and the variables are divided year by year covering the period from 1998 to 2006. In this dataset, we had more than 5.000 observations of more than 2.500 variables. The point of departure has been the harmonization of names of the variables between the two datasets. Once the names were harmonized, we proceeded identifying the variables we had in both datasets in order to see how much information we had over the whole period.

The merging procedure has been carried out considering an identification variable in order to pair for different periods the observations for the same firms.

To these data, we appended balance sheet data gathered in three different dataset containing detailed information on capitalization, debt exposure, sales and revenues, etc.

There are other works that have used the SIMF Unicredit-Capitalia data with different strategies and different approaches. Piccardo et al. (2014) consider a dataset obtained merging from the 6th to the 9th waves and, given that they noticed a very big change in the sample occurred between the 7th and 8th waves of the survey, they decided to keep the firms observed both in

the 6th and 7th and both in the 8th and 9th waves ending up with a sample of 1.165 firms.

Bratti and Felice (2012), use data from the 8th and 9th waves, because, according to them, "using a 3-wave or a longer panel would greatly reduce the number of firms and induce potential selection problems".

The rotation of the firms between the different waves if, on one hand, is useful to understand both variations over time for the firms observed in different waves (panel section) and the structural changes of the Italian economy, on the other hand, it is affected by the different reasons which drive firms to drop out from the sample such as non-response, cessation of activity, drop of firm size under 11 employees, change of sector.

Besides, if the investigation is biased only on surviving firms there might be a survivorship bias. In this case, it is highly likely that the selection of the sample is significantly correlated with the same variables which may potentially affect firm performance.

To check whether findings are robust to the survivorship bias effect, Becchetti and Trovato (2002) consider two waves of the Survey (1992-1994 and 1995-1997) and include in the sample only those firms participating in both surveys plus those participating in the first but not in the second.

We are aware of some problems related to merging more than two waves of the survey: Nese and O'Higgins (2007), considering from the 5th to the 8th waves of the Capitalia survey, study the sample entry and exit behaviour trying to understand if constructing panels over more than one wave might cause problems of panel attrition. The problem the authors address is that missing data in panel surveys may be caused by different motivations (non-response or the firm may drop out of the sample for subsequent waves) and this may

cause biased estimation of the parameters. If the mechanism causing non-response is random (the lost observation and the remaining one exhibit similar patterns), the missing data problems affects only the representativeness of the original sample; but if the causes of non-responding are related to the problem studied by the researcher, there can be a bias. The authors argue that the cause of exit from the sample may be different (non-response, bankrupt, taking over or mergers) and the firms retained in the panels seem to be more likely to have received financial subsidies by the government. So, to overcome some problems of panel attrition, we used appropriate tests on the variables as in Verbeek and Nijman (1992) cited in Wooldridge (2002) introducing in the regression a dummy variable indicating if an observation is present also in the following wave.

Our choice, however, meets several objectives of our research: we need to have a longer series of firm level data for Italy in order to implement panel data analysis, to have more instruments to address endogeneity by adopting lagged values of our variables, to study the role of persistence in innovation and international activities (which will be the focus of the third paper of the Dissertation).

Appendix 1 - The Melitz model.

In his seminal work published on *Econometrica* in 2003, Melitz developed a dynamic industry model of monopolistic competition with heterogeneous firms that has become the cornerstone of a growing stream of literature that examines the role of heterogeneity in international trade. Even if there are other related models successively developed (e.g. BEJK, 2004) the model by Melitz has achieved resounding success because it comes to results that can be confronted with data leading to remarkable results.

The main results from Melitz's model are derived from the interaction between productivity differences across firms and sunk market entry costs (e.g. distribution and servicing costs) that firms have to face, not just for their domestic market, but also for any potential export market, and a firm has to bear them in every country to which it exports. As a result, the total fixed export costs are larger the more foreign countries the firm chooses to serve. The findings of the model are multiple and it is useful as a theoretical foundation to different empirical findings; what we want to underline is that it models some conditions according to which firms decide to serve only domestic or also foreign markets. So in this focus we want to explain how the author derives these conditions.

Melitz starts considering different countries such that each country trades with $n \geq 1$ countries, the consumer faces a preference defined with a Constant Elasticity of Substitution (CES) or Dixit & Stiglitz (1977) form:

$$C = \left[\int_{\omega \in \Omega} q(\omega)^{\rho} d\omega \right]^{\frac{1}{\rho}}, \qquad 0 < \rho < 1, \tag{1}$$

where ω indexes varieties, Ω is the (endogenous) set of varieties, and the price index dual to (1) is:

$$P = \left[\int_{\omega\in\Omega} p(\omega)^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}}, \qquad \sigma = \frac{1}{1-\rho} > 1, \tag{2}$$

where σ corresponds to the elasticity of substitution between varieties.

The model can be interpreted as capturing an industry within an economy. The assumption of CES preferences implies a strong "love of variety": the utility increases with the varieties consumed and, conversely, it diminishes from the consumption of any given variety; and the marginal utility from consumption of any given variety approaches infinity as consumption approaches zero.

Given these preferences, the revenue function for operating in the domestic market is given by:

$$r_d(\omega) = R\left(\frac{p_d(\omega)}{P}\right)^{1-\sigma}, \tag{3}$$

where *R* is the aggregate revenue, which equals aggregate income, which equals aggregate expenditure; the *P* is the price of different competing varieties and $p_d(\omega)$ is the price of variety ω in the domestic market.

Potentially, we can assume that there are potential entrants that can enter the market paying a sunk entry cost. Nevertheless they face uncertainty about their productivity in the industry and, once the sunk entry cost is paid, a firm draws its productivity φ from a fixed distribution, $g(\varphi)$. Productivity remains fixed after entry, but firms face a constant exogenous probability of death

δ, which induces steady-state entry and exit of firms in the model.

On of the central assumption of this model is that the production cost involves a fixed production cost of f_d units of labor and a constant variable cost that depends on firm productivity. The total labor required to produce $q(\varphi)$ units of a variety is therefore:

$$l(\varphi) = f_d + \frac{q(\varphi)}{\varphi}. \qquad (4)$$

In this model, the assumption that there is a fixed portion of the production cost that is fixed is essential because it justifies that productivity differences entail firms' survivorship in the market: firms showing low productivity cannot generate enough variable profits to cover the fixed production cost and so, as confirmed by some empirical findings, exiting firms are on average of lower productivity than surviving firms. Moreover, if firms decide to export, they face a fixed exporting cost of f_x units of labor and "melting iceberg" variable costs of trade, such that $\tau > 1$ units must be shipped in order for one unit to arrive in a foreign country.

As each firm is supposed to be of a negligible size relative to the size of the industry, the aggregate price is taken as given. Melitz explains that, starting from the standard result that equilibrium prices are a mark up over the marginal cost that the elasticity of demand is constant and the same in domestic and export market, a firm revenue expression in equilibrium in the domestic and export markets is given by:

$$r_x(\varphi) = \tau^{1-\sigma} r_d(\varphi) = \tau^{1-\sigma} (\rho\varphi)^{\sigma-1} RP^{\sigma-1} \quad (5)$$

So if we consider the relative revenue of any two firms, we see that it depends on their relative productivities and on variable trade costs.

$$\frac{r_d(\varphi'')}{r_d(\varphi')} = \frac{r_x(\varphi'')}{r_x(\varphi')} = \left(\frac{\varphi''}{\varphi'}\right)^{\sigma-1} \quad (6)$$

Moreover, if we consider that firm's profit in each market is equal to the variable profits minus the relevant fixed costs, we can derive two cut-off point:

- the *zero-profit cutoff productivity (φd*)* below which firms exit immediately the market since they make negative profits:

$$r_d(\varphi_d^*) = (\rho\varphi_d^*)^{\sigma-1} RP^{\sigma-1} = \sigma f_d \quad (7)$$

- the *exporting cutoff productivity (φx*)* below which firms serve only domestic market since they would make negative profits if they decided to export:

$$r_x(\varphi_x^*) = \tau^{1-\sigma} (\rho\varphi_x^*)^{\sigma-1} RP^{\sigma-1} = \sigma f_x \quad (8)$$

Combining these two conditions with relative revenues, we obtain the following relationship:

$$\varphi_x^* = \Lambda \varphi_d^*, \qquad \Lambda \equiv \tau \left(\frac{f_x}{f_d} \right)^{\frac{1}{\sigma - 1}} \tag{9}$$

So we can conclude that, for sufficiently high values of fixed and variable trade costs, the model features selection into export markets: $\Lambda > 1$. This confirms that only the most productive firms can face these costs and export, while intermediate productivity firms serve only the domestic market, and low productivity firms exit from the market.

In his paper, however, the author addresses other challenges: for example, it shows how further increase in the industry's exposure to trade lead to inter-firm reallocations towards more productive firms; or it also shows how the aggregate industry productivity growth generated by the reallocations contributes to welfare gain, thus highlighting a benefit from trade. Being so comprehensive and forward-looking explain why this paper, and thus the model, has played such an essential role in this literature.

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DO FIRMS LEARN FROM INTERNATIONALIZATION? THE IMPACT OF INTERNATIONALIZATION CHOICES ON INNOVATION.

Chapter 2

1. Introduction.

A general and commonly accepted finding from micro-econometric studies on trade is that "better" firms self-select into export markets, while exporting does not necessarily imply increased learning (Wagner 2007). While the empirical evidence on self-selection into exports is large and in accordance with theoretical predictions, the learning-by-exporting has been the subject of growing research because of the weak empirical support it has received. Whereas the existing literature typically examines learning-by-exporting by considering differences in productivity, in this study we want measure the effect of different internationalization strategies on innovation performance. Taking advantage of the traditionally larger availability of data on export activities more than on other strategies, export has been the most widely used class of international involvement. However we want to compare the effects of different strategies of internationalization on innovation to see which could allow firms to perform better in innovation to gain competitive advantage on their less innovative counterparts.

The economic literature has highlighted, indeed, the existence of a positive relationship between competitiveness and degree of internationalization at firm level identifying different level of complexity concerning internationalization strategies (with this picking order export, import, two-way traders, outsourcing, FDI) (e.g. Mayer et al., 2007; Altomonte, 2013; Costa et al., 2016).

Exporting is an important and initially preferred strategy of internationalization because it involves lower levels of commitment and risk, compared to FDI, as firms do not have to deal with costs and complexities of setting foreign establishments.

Another important strategy of internationalization can be considered foreign direct investments (FDI). Commonly defined as a firm's allocation of business activities by investing in a foreign country, FDIs have been considered a more complex internationalization strategy than export. It is based on foreign affiliates, or subsidiaries, or creating a joint venture, and it has been studied by different streams of literature looking at both sides of this strategy: on one side, the determinants of firms' decision to internationalize production, and, on the other side, the direct and indirect effects of this kind of activities on host and home economies (Castellani et al., 2015).

Traditionally, a number of studies have provided evidence that firms internationalizing production are more productive and, in turn, investing abroad may enhance the productivity of internationalized firms (Wagner, 2012).

The debate on the effect of offshoring on domestic economies is still an open question (Castellani, et al. 2015). On the one hand, there are studies arguing that investing in R&D increases the firms' ability in creating knowledge (Zanfei, 2000; Narula and Zanfei, 2005), since there can be a reverse knowledge

transfer from foreign firms to the parent company and also because an investment abroad might allow firms to concentrate on their core competences which might enhance firms' strategic investment in R&D. On the other hand, there are studies highlighting that there could be the risk that firms offshoring strategic activities could lose their knowledge and abilities in favour of new firms or countries emerging with new capabilities (Narula, 2002).

The third analyzed strategies is the outsourcing. Following Gilley et al. (2000), it can be defined as "a highly strategic decision that has the potential to cause ripple effects on the entire organization". It can arise through the procurement of external purchases for internal activities of product that have been previously completed internally (*substitution-based*) or through the acquisition of goods and service that have never been produced by the firm (*abstention-based*). A number of work has studied the effects of outsourcing distinguishing advantages and disadvantages of this strategy. If there are studies finding financial and non-financial advantages of outsourcing, there are others underlining that this strategy could be a serious threat for innovation by the outsourcers, since it could be often used as substitute for innovation.

The aim of this work is to shed additional light on the relationship between innovation and internationalization. Controlling on firms' specific characteristics (e.g. size, capital intensity, level of investment in R&D, ownership,) we will investigate if there can be some post-entry in international markets effects on innovation, with the aim to contribute to the branch of learning-to-innovate-by-exporting (LIBE) literature. Another purpose we want to achieve is to understand which kind of internationalization choice has greater effects on the innovation performance. Given that the literature has identified

a positive relationship between competitiveness and degree of internationalization at firm level identifying different level of complexity concerning internationalization strategies we will see which channel of trade (focusing on exports, FDI and outsourcing) has a stronger impact on firms' innovation performances

We deal with these issues with different complementary methodologies. Firstly, we estimate an OLS model to set the benchmark of the relation between the variables, then a probit adoption delayed variables to elaborate very preliminary results on causal relationship, and finally, to cope with possible endogeneity and self-selection bias effects, we apply propensity score matching in order to control for endogeneity and sample selection problems. Moreover, in the Appendix of the chapter of our study, we deal with "selection bias due to unobservables" problem using the method proposed by Heckman (1974, 1978, 1979), a seminal contribution in modeling sample selection

The paper is organized as follows: in the following session, there is a review of the main literature, theoretical and empirical; in section 3 we describe the data, the variables definition and provide some descriptive statistics; in the subsequent section, we show and comment the results we get from our analysis; some conclusions follow.

2. Literature review.

The study of the relationship between innovation and internationalization dates back to early nineties focusing mostly on the effects that internationalization can have on firms

productivity documenting this relation following the two aforementioned different paths: the self-selection mechanisms and the learning-by-exporting (LBE) hypothesis.

The first hypothesis has more solid theoretical background (Melitz 2003, Constantini, Melitz 2008) which findings have been strengthened by the empirical literature (Aw et al., 2000; Bernard and Jensen, 1999; Clerides et al., 1998; Greenway and Kneller 2007), whereas the LBE has less empirical evidence being an under-explored topic with comparatively less contributions supporting this hypothesis (Salomon and Shaver, 2005; Wagner, 2007, 2012, 2015; Silva et al., 2012; Van Beveren and Vandenbussche, 2010; Bratti and Felice, 2012; Damijan, 2015).

The most relevant issue behind both hypotheses is that firms are substantially heterogeneous under several aspects and these specific characteristics influence both ex-ante, the decision to undertake international activities justifying the self-selection, and ex-post performance, meaning the way they can internalize knowledge flows coming from foreign markets.

The economic literature questioned what are the the drivers of internationalization decisions and one of these can be found in R&D and innovation investments (see Griliches, 1998) finding that these are important elements to explain ex-ante productivity differences and ex-post assimilation process of knowledge.

The bunch of works related to this field has succeeded, for example, in explaining that innovation has a positive impact on the propensity to export (Greenaway and Kneller 2007; Wagner 2007; Bellone et al. 2010; Cassiman and Golovko, 2011) and, on the other side, there is a branch of research that highlighted the importance of exporting in enhancing the productivity of the firms and the decision to innovate (Salomon and Shaver, 2005;

Wagner, 2007, 2012, 2015; Silva et al., 2012; Van Beveren and Vandenbussche, 2010; Bratti and Felice, 2012; Damijan, 2015).
From a theoretical perspective, the traditional economic models were more able to explain formally, considering the inter-firm differences, the self-selection mechanism rather than the learning-by-exporting hypotheses.
Concerning the economic theory, this has progressively shifted from an industry level analysis to a micro level perspective in which the specific firms characteristics have a growing central role in explaining differences in performance and decision-making processes.
However, in this literature, as said, the theoretical work by Melitz (2003) is a crucial milestones in providing theoretical foundations to the so called New trade theories because it introduced, as said, the presence of a large heterogeneity and of a selection mechanism in both the participation in international markets decisions and also in the level of sales that a firms complete abroad with respect to the total amount of sales. According to this model, firms that decide to enter foreign markets have to face sunk costs that they can face only overstepping a threshold level of productivity derived according to their characteristics.
Starting from these findings, there are other models that consider the causal relation between productivity and exporting: Bernard, Eaton et al (2003), introducing Bertrand competition into an extension of the Ricardian framework with a given set of goods, still explain that competition on foreign markets boosts the plant productivity.
Helpman, Melitz and Yeaple (2003) in a multi-country, multi-sector general equilibrium model, confirm the relevance of firm level heterogeneity as a key determinant of relative export and FDI flows influencing the decision of (heterogeneous) firms to

serve foreign markets either through exports or the possibility for firms to sell directly to the host country (horizontal FDI). In their framework, the intermediate productivity firms decide to serve the foreign markets, the most productive among this group will further choose to serve the overseas market via FDI, whereas market and low productivity firms serve the domestic market.

Costantini and Melitz (2008) incorporating the heterogeneity of firms in a dynamic model, in the context of liberalization of trade regimes, jointly consider innovation decisions (subject to sunk costs) and/or entry (exit) export market, proving the self-selection of more productive firms into export markets. This decision in a context of trade liberalization is also influenced by firms expectations about current and future trade costs.

Also Bustos (2011) and Aw et al. (2011) consider in their model heterogeneous firms and both innovation and foreign market participation with productivity influencing firms performance.

Reflecting the chance of perspective of the the theoretical literature and the growing relevance acknowledged to the heterogeneity of the firms, on the empirical ground, as well, it has been recognized that firms' characteristics may have different effects on productivity, innovation and degree of internationalization motivating the study of interrelations between all these aspects (Bernard and Jensen 1995; Greenaway & Kneller 2007; Wagner 2007, 2012, 2014; Caleb et al. 2015, to quote some).

The pivotal role of productivity as a proxy of firms' performance to measure of the the effect of R&D investments and activities has been documented by an extended literature from the paper by Griliches (1979) up to more recent studies (e.g. Clerides 1998, Wagner 2006). The results documented by

this literature are broadly accepted and, in particular, the role of R&D in enhancing firm's productivity.
If it is true that among the characteristics that can influence firms' decisions, the positive effect of innovation on the probability of participation in export markets has been found by several works (Caldera, 2010; Ganotakis and Love, 2009; Cassiman and Golovko, 2011; Bravo-Ortega et al. 2013, to quote some), many questions have still not yet been answered about how the causal relation works.
The first and most relevant work in this field is the one by Salomon and Shaver (2005), on Spanish firms, who find, even in presence of not homogeneous results over sectors because of some industry factors, that firms increase their production, product innovation and patent application subsequent to becoming exporters and, moreover, less developed countries stand to gain more from trade than developed ones.
Moreover, knowledge flows can come from different levels of involvement in international market - because globally engaged firms have access to larger stocks of knowledge through contacts with foreign customers and suppliers - with different effects (e.g. Criscuolo et al.,2010; Damijan et al., 2015 on import/export).

Focusing on Italy, even if few studies focused on the relationship between trade and innovation, some of them, reflecting, also in this case, the changed perspective in explaining exporting performance from an industry level determinants approach to a more firm specific one, have found evidence in step with international economic literature documenting evidence in favor of a positive effect on trade due to R&D expenditure (e.g. Sterlacchini 2001, Basile 2001) and that non-

exporting firms turn out as the worst performers with respect to firms involved in international activities (Sterlacchini, 2001; Brancati et al. 2015).

Also if we restrict the focus on the Italian case of study, the literature is divided in one stream studying the effect of innovation and R&D on being involved in international trade and viceversa, mostly focusing on export as internationalization strategy: Basile (2001), for example, following Wagner (1998), finds evidence that innovation is very crucial factor in explaining firm level heterogeneity in export behaviour; similarly, Castellani and Zanfei (2007), even if the data they use have some limitations we have already mentioned in previous chapter, uncover evidence that firms, being involved in international activities, ensures productivity premium and better innovative performance; moreover, Nassimbeni (2001) finds that the propensity of small units to export is strictly linked to their ability to innovate; Benfratello and Razzolini (2009), through the estimation of different measures of TFP, find that there is a productivity ranking among domestic firms, exporters and FDI performers with the latter showing the higher productivity; Frazzoni et al. (2012), for example, find some evidence that also bank-firm relations may have a (positive) impact on export participation and, on the contrary, the strength of export affects the probability that a firm introduces product innovation.

Firms' choices on internationalization, however, can concern different strategies (two way trading; FDI; outsourcing; etc.) and they can have different effects on innovation. On the side of the learning-by-exporting framework, indeed, there are works (e.g. Bratti and Felice, 2012, Accetturo et al., 2014) showing that export status affects the propensity of firms to introduce innovations and an increase in foreign demand is an important

driver for innovation to boost firms' incentives to innovate and introduce new products.

If we look at the possibility of investing abroad, the FDI choice, the literature found positive and negative effects of this strategies on innovation. On the one hand, some authors have argued that internationalization (mainly via FDI and cooperative alliances) allows firms to gain access to new technologies augmenting or complementing firms' existing knowledge stock finding some valuable resources for companies wishing to be innovative as human capital in a cheaper, faster and less risky way than in-house (Chung and Yeaple, 2008; Quinn, 2000).

On the other hand, it has been highlighted that offshoring may be a risk since firms offshoring strategic activities may lose competitive advantages in favor of new firms.

A similar debate is still open for what concerns the outsourcing since it may lead to some potential financial and non-financial benefits.

The former kind of advantage is usually identified in cost ones: outsourcing firms, indeed, usually achieve a benefit with respect to vertically integrated firms since manufacturing costs usually decline since firms can switch suppliers in favour of more advantageous and technologically advanced ones (Gilley et al. 2000). Moreover, outsourcing may lead to non-financial advantages such as an increased focus on core competences of the firms that, if on one side it may be reduction of flexibility in the long run, on the other one it allows to concentrate all managerial and financial resources on those activities on which the firms does its best.

The downside of outsourcing is a decline in innovation by the outsourcer because it is often used as a substitute for innovation leading the firms to loose touch with more advanced technological breakthroughs (Teece, 1987) and, moreover,

suppliers could gain knowledge that may lead them to become firms' competitors.

Some authors assert that a way to understand how firms learn from their international involvement is to consider important elements such as investments in technology made by firms to absorb and assimilate knowledge spillovers (e.g. Aw, Roberts and Winston, 2005) and the strategy they implement, given that different strategies (outsourcing, exporting, FDI) may lead to different results (Altomonte et al., 2013).

The positive correlation between innovation and internationalization at the firm level and the strength of this correlation increases with the complexity of the internationalization strategy and even if larger and more productive firms may benefit more from foreign contacts (as the "happy few" in Mayer and Ottaviano, 2007) also smaller and less productive firms can choose the right mix of internationalization and innovation activities. In conclusion, the literature reviewed has underlined the importance of both innovation and internationalization activities as drivers for increasing firms production. The study of the relation between these two variables may have important implication for policy makers in order to implement more effective policies to encourage innovation.

3. Data and descriptive statistics.

In our work, we consider, as said, firm level data on Italian firms drawn on three waves of a survey: from the 8th (1998-2000) and 9th (2001-2003) Capitalia Survey of Manufacturing firms (Indagine sulle imprese manifatturiere, SIMF or Capitalia

Survey) managed by the Capitalia banking group (formerly Mediocredito Centrale and now member of the UniCredit Group) and from the X-Wave (2004-2006) of the Capitalia-UniCredit survey[11]. We merge the three waves and this gives us a balanced panel of more than 19.000 observations[12].

As already said, the data are gathered from a detailed questionnaire submitted by all companies customers of Capitalia with more than 10 employees and the survey is on samples of firms from 11 to 500 employees and a census for firms with more than 500 employees.

The dataset provides, in particular, useful information, for our analysis, on the activity of the firms and their interrelated strategy of internationalization and innovation allowing to distinguish the purely domestic ones from the exporters and the ones engaged in other forms of internationalization (off-shoring, indirect trade, agreement of collaboration, FDI, outsourcing, etc.). The variables on innovation follow closely the information contained in the Community Innovation Survey[13].

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[11] The institutes providing Capitalia-Unicredit data are UniCredit (Mediocredito) and CERVED Centrale dei Bilanci. The data provide qualitativa and quantitative information concerning several firms characteristics: ownership structure, workforce composition, internationalization and innovation activities.

[12] For a more detailed description on the dataset construction, see Appendix.

[13] The CIS, provided by the EUROSTAT, is a survey of innovation activity in enterprises designed to provide information on the innovativeness of sectors by type of enterprises, on the different types of innovation and on various aspects of the development of an innovation, such as the objectives, the sources of information, the public funding, the innovation expenditures etc. The CIS provides statistics broken down by countries, type of innovators, economic activities and size classes.

The surveys we use repeated over time at three-years intervals and the panel design is stratified and rotating so in each wave a part of the sample is fixed over time while the other part is renewed[14].

Table 1 - Splitting the sample by Industries

ATECO classification (2 digit)	Freq.	Percent.	Cum.
Unknown	66	0,47	0,47
Food, beverages and tobacco	1,353	9,69	10,17
Textiles, apparel and clothes	1,522	10,91	21,07
Leather and shoes	575	4,12	25,19
Wood, wood products and furnitures	392	2,81	28,00
Pulp, paper, paper products	371	2,66	30,66
Printing and publishing	442	3,17	33,83
Petroleum and coal products	60	0,43	34,26
Chemicals	689	4,94	39,19
Rubber and plastics products	725	5,19	44,39
Glass and ceramic materials	268	1,92	46,31
Building materials	600	4,30	50,61
Iron and steel	506	3,63	54,23
Fabricated metal products	1,971	14,12	68,36
Materials and mechanical equipment	247	1,77	70,13
Machinery and equipment	1,614	11,56	81,69
Electronics	68	0,49	82,18
Electrotechnics	854	6,12	88,30
Precision mechanics	329	2,36	90,66
Motor vehicles and trailers	241	1,73	92,38
Other means of transport	141	1,01	93,39
Other manufacturing, recycling	922	6,61	100,00
Total	13,956	100,00	

[14] See Chapter 1 for further details.

Merging the three waves our final estimation panel (EP) turns out to keep all the informations contained in the different waves.
Splitting our final sample into industries (Table 1) and into different dimensions, indeed, the EP seems to be fairly representative of the general Italian economic scenario.
We can see that the most common industry sector is represented by the "fabricated metal products" while the less frequent is the petroleum sector
Whereas, as shown in Table 2, if we look at the dimension of the firms, more than half of the firms in our sample are concentrated in the first two classes, confirming the traditional finding that the Italian economic scenario is mainly composed by SME.

Table 2 - Dimensional classes

Classes (by number of employees)*	**Freq.**	**Percent**	**Cum.**
<20	4,179	29,63	29,63
20-49	4,963	35,18	64,81
50-249	3,620	25,66	90,47
>=250	1,344	9,53	100,00
Total	14,106	100,00	

*The average number of employee is calculated as a mean over the period (1998-2006).

Now we consider some preliminary descriptive statistics to see how, in our sample, the two dimension of our study are represented (innovation and internationalization).
Looking at the different internationalization strategies we consider[15], as shown in Table 3, exporting is the most common strategy since more than a third of the firms (67,43%) has exported in the last year of the period considered.

Table 3 - Internationalization strategies - Estimation Panel (1998-2006)

	Strategy	
	Yes	**No**
Export	**67,43%** (9.462)	**32,57%** (4.571)
Outsourcing	**12,25%** (1.728)	**87,75%** (12.378)
FDI	**3,11%** (282)	**96,89%** (8.796)

Frequencies in parenthesis.
Source: own calculation

[15] The variables of internationalization strategies are dummy variables derived from the questionaries of the different wave. For what concerns exporting, the questions are homogeneous through the years: firms are asked to indicate whether or not they have fully or partly exported products in the last year considered (2000, 2003, 2006). Also for what concerns FDI the question is similar since firms are asked to indicate if they have invested abroad, but in this case the question is about the three years period. The construction of the outsourcing variable, instead, has been made on question that changed a little bit through the years. The dummy variable indicates if the firms has developed part of the production process abroad through technical or commercial agreements with foreign firms.

Table 4 - Forms of internationalization and firms characteristics - means calculated for 1998-2006

Forms of Internationalization

Export

Firms characteristics	Yes			No		
	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev
Average age (in years)	9.220	40,8	22,2	4532	36,3	18,9
Average Number of Employees	9.286	126,8	420,5	4.468	51,1	177,8
Average capital intensity (in thousands of €)	6.402	169,7	840,3	3.228	160,6	738,4
Average productivity (Value added per employee)	6.407	66.071,9	341.888,8	3.234	60.736,5	304904.4

FDI

Firms characteristics	Yes			No		
	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev
Average age (in years)	268	44,60	25,80	8.646	40.1	18.81788
Average Number of Employees	279	333,91	1.010,77	8.766	91.8	283.1491
Average capital intensity (in thousands of €)	158	417,08	3.962,54	4.991	48.8	141.2147
Average productivity (Value added per employee)	159	63.804,1	76.278,83	5.074	51.643,5	229604.1

Outsourcing

Firms characteristics	Yes			No		
	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev
Average age (in years)	1.649	40.8211	22.09127	12.170	39.147	21.16719
Average Number of Employees	1.700	174.3962	655.986	12.120	92.29255	296.5995
Average capital intensity (in thousands of €)	990	135.8459	285.7907	8.680	170.0212	845.1273
Average productivity (Value added per employee)	988	85911.69	528376.1	8.692	61775.95	298304

Source: own calculation

The outsourcing and FDI strategies show similar percentages, with a smaller number of firms preferring these types of strategy (8,68% and 3,11% respectively).

Moreover, looking at some specific firms' characteristics (Table 4), according to the chosen internationalization strategy, we can see that firms that choose the FDI strategy show a larger capital intensity and a larger average size (according to the number of the employees) confirming that the importance of size increases with the complexity of the strategy of internationalization, starting from the exports, to commercial agreements and, finally, to FDI (Bugamelli, 2000 ; Costa et al. 2016).

Firms choosing outsourcing, instead, show a greater productivity measured through the value added per employee.

Looking at the Table 5, if we consider the innovation performance, instead, we can see that 54,75% of firms has introduced at least one kind of innovation and the most

Table 5 - Innovation performance (1998-2006)

	Yes	**No**
Innovation	**54,75%** (7.461)	**45,25%** (6.167)
Product Innovation	**39,89%** (5.436)	**60,11%** (8.192)
Process Innovation	**28,92%** (3.941)	**71,08%** (9.687)
Organizational Process Innovation	**12,65%** (1.174)	**87,35%** (11.904)
Organizational Product Innovation	**8,45%** (1.152)	**91,55%** (12.476)

common type of innovation introduced is the product innovation (39,89%) followed by the process innovation (28,92%).
Less commonly, instead, the firms in our sample seem to introduce organizational innovation, both regarding process (12,65%) and product (8,45%).
If we consider jointly the introduction of innovation and the internationalization strategy, we can see that exporting firms have introduced any type of innovation in the 59,69% of the cases, less than FDI makers and outsourcers that seem, at a first look, to be the most innovative ones.
Among the different types of innovation, the most common one turns out to be the product innovation between exporters, foreign investors and outsourcing firms as well.

Table 6 - Internationalization and Innovation strategies (1998-2006)

	Strategy		
Type of Innovation	**Export**	**FDI**	**Outsourcing**
Innovation	59,69%	70,36%	68,73%
Product Innovation	45,35%	57,60%	55,75%
Process Innovation	29,83%	30,36%	28,99%
Organizational Product Innovation	9,69%	13,93%	11,96%
Organizational Process Innovation	13,58%	15,71%	15,56%

What we are really interested in, is the causal relationship that may occur between these two dimensions. In order to uncover it, in the following session, we implement first a probit estimation and then a propensity score analysis.

4. Estimation strategy and results.

In the literature, the authors have adopted various methodological options to study if a causal relation exists (for an exhaustive survey, see Wagner 2012). In our study, as a first step we use a random effect probit estimation with delayed variables to look at the existence of any causal relationship. In a second stage, we implement propensity score matching, in order to improve the estimation results.

Initially the probit model is used to estimate different equations according to different internationalization strategies. The aim in doing this is to have a first measure of which strategy is more likely to have a positive effect on innovation. Following the same strategy of Aw et al. (2007), Girma et al. (2008), Damijan et al. (2010), Damian et al. (2015), the control variables we use are the same in all the equations.

A great challenge in the evaluation of the causal relationship of a firm's internationalization strategy on innovation is to disentangle spurious correlations, due to unobserved heterogeneity, from causality (Bratti and Felice, 2012).

Then firms' internationalization decisions are, indeed, non-random and so there can be two possible sources of bias: "selection bias due to observables" due to some specific differences that researchers can observe but fail to control; and the "selection bias due to unobservables" deriving from firms'

differences that affect the decision to undertake internationalization strategies but that are unobservable and thus uncontrolled (Costa et al., 2016).
In both cases, using OLS may lead to biased results. In the literature an econometric tool largely used to overcome selection bias problems due to observable is the propensity score matching (PSM) method that we implement in Section 4.2; moreover, we cope with selection bias due to unobservables in the appendix using the Heckman model.

4.1 First step: Probit Estimation.

In our probit estimations, the main dependent variable is the innovation performance measured as the introduction of any type of innovation and of product innovation. For our analysis, first of all we use a main dependent dummy variable (*innov*) identifying if a firms ha developed any kind of innovation in the previous period, than we compare these results with the other form of innovation (*innovprod*).
For what concerns the internationalization strategy, we use three different lagged dummy variables indicating respectively if the firm has exported, invested abroad or outsourced in the previous period (*_ha_expor, _FDI, _outsourcing*).

Table 7 - Variables description

Variable	Obs	Mean	Std. Dev.	Min	Max
innov	13628	0.547	0.497	0	1
innovprod	13628	0.398	0.49	0	1
_ha_expor	3648	0.727	0.446	0	1
_FDI	3099	0.03	0.169	0	1
_outsourcing	3146	0.159	0.366	0	1
lage	13819	3.564	0.453	2.197	5.79
_isgroup	3651	0.272	0.445	0	1
_capintensity	3183	32.474	86.679	0	2792.47
_VAempl	3218	46000.73	23920.21	2084.18	472623.5
_hares	3584	0.446	0.497	0	1
_sogest_ctrll	4078	0.064	0.245	0	1
_patents	3571	0.023	0.149	0	1

In order to consider the heterogeneity that could affect the decision to innovate, we consider some firms specific characteristics: the age of the firm in log (*lage*); a lagged dummy indicating if a firm is in group of companies (*_isgroup*); the lagged capital intensity calculated as the ratio between total asset and turnover (*_capintensity*); the productivity (expressed in Euros) measured as the value added per employee and calculated as the

ratio between the value added and the average number of employees (*_VAempl*).

Another aspect that could influence the innovation performance are the technological inputs and international spillovers. We consider the former dimension through two different lagged dummy variables indicating if the firm has invested in R&D in the previous period (*_hares*) or if it has bought patents from abroad (*_patents*); the latter one, instead, is captured by a lagged dummy variable indicating if the controlling shareholder is Italian or not (*_sogestr_ctrl*)[16].

Finally, we use a set of industry and region dummy variables (*i.industry, i.reg*) and a dimensional dummy (*i.dim*) dividing the firms in 4 classes according to the number of employees (less than 20, in the range 20-49 and 50-249, and more than 250).

The criteria used to choose these variables come out from existing economics of innovation literature and it is also partly dictated by data availability. For example, the impact of size on firms' (innovation) performance has been largely documented suggesting that larger companies turn out to be more prone to introduce innovations. Is it also important to introduce the age in the estimations, since if, on one hand, it could be an important driver of innovation because more mature firms can benefit from experience more than younger ones (Noteboom, 1993); on the other, older firms could also be less flexible and they could face more problems in introducing innovation. Moreover, being part of a group, could improve the internal

[16] It is worth to specify that some variables in the questionnaire are referred to the whole period the survey is referred to (innov, innovprod, FDI, outsourcing) while others are referred to the last year of the period (_ha_expor).

flow of knowledge and competences that could lead to better performance in innovation.

Capital intensity is useful to understand the level of intangible assets or if firms are more capital intensive. Introducing R&D, instead, can confirm if, as expected, investing in R&D in the previous period, can lead to introduce innovation in the following.

So, first of all, we run three different random effect probit estimation for the three different strategies considered. The equation[17] we want to estimate is the following:

$$P(Innov_{it}=1) = \alpha + \beta_1\, strateg_{it-1} + \beta_2\, lage_{it-1} + \beta_3\, isgruppo_{it-1} + \beta_4\, capintensity_{it-1} + \beta_5\, VAempli_{i-1} + \beta_6\, hares_{it-1} + \\ + \beta_7\, sogestrctrl_{it-1} + \beta_8\, patents_{it-1} + \gamma \sum_{m=1}^{M} industry_m + \delta \sum_{s=1}^{S} \text{reg}_s + \zeta \sum_{q=1}^{Q} \text{dim}_q + \varepsilon_{it} \qquad [1]$$

[17] We present probit equation with RE using as dependent the innovation. The decision to run a RE estimation, instead of a FE one, has been tested and motivated by the results of a comparison according to the Hausman test. When we estimate the other types of innovation, we change the dependent variable.

Table 8 - Probit estimation results for any type of innovation

	(1)	P.P.(1)	(2)	P.P.(2)	(3)	P.P.(3)
Export	0.261*** (0.073)	(0.086)				
FDI			0.460** (0.217)	(0.153)		
Outsourcing					0.277*** (0.089)	(0.092)
lage	0.051 (0.077)	(0.017)	0.029 (0.077)	(0.01)	0.036 (0.077)	(0.012)
_isgruppo	0.060 (0.082)	(0.02)	0.037 (0.082)	(0.012)	0.045 (0.082)	(0.015)
_capintensity	-0.003*** (0.001)	(-0.001)	-0.003*** (0.001)	(-0.001)	-0.003*** (0.001)	(-0.001)
_VAempl	2.17e-06 (1.58e-06)	(7.20e-07)	2.71e-06* (1.58e-06)	(9.04e-07)	2.55e-06 (1.58e-06)	(8.47e-07)
_hares	0.717*** (0.067)	(0.238)	0.756*** (0.066)	(0.252)	0.720*** (0.067)	(0.239)
_sogestr_ctrl	-0.084 (0.143)	(-0.028)	-0.077 (0.144)	(-0.026)	-0.083 (0.142)	(-0.027)
_patents	-0.103 (0.218)	(-0.034)	-0.099 (0.219)	(-0.033)	-0.151 (0.219)	(-0.05)
dimension (n. empl.)						
20-49	0.168** (0.079)	(0.058)	0.184** (0.078)	(0.064)	0.181** (0.078)	(0.061)
50-249	0.443*** (0.087)	(0.154)	0.472*** (0.087)	(0.164)	0.472*** (0.087)	(0.164)
>=250	0.699*** (0.137)	(0.238)	0.7199*** (0.137)	(0.246)	0.724*** (0.136)	(0.247)
Industry	(Yes)		(Yes)		(Yes)	
Region	(Yes)		(Yes)		(Yes)	
No. firms	1.989		1.992		1.996	

Standard errors in brackets; * p<0.1; ** p<0.05; *** p<0.01.
Source: own calculation. Industry and region dummies included. In columns (1), (2), and (3), the average marginal effects calculated at the means are displayed. Predicted Probabilities in column P.P.

According to the innovation type considered, the dependent ($Innov_{it}$) will be any type of innovation or product innovation and process innovation[18], and the main independent ($strateg_{it}$) will likewise change in accordance with the internationalization strategies considered (*_ha_expor, _FDI, _outsourcing*).
Looking at the results[19] in Table 8, we can see that exporting, FDI and outsourcing the results have a positive coefficient. When we consider exporting strategy, the results show positive and significant coefficient for firms that undertake this strategy;

[18] It is worth to highlight that, as Battisti and Iona (2009) point out, there can be some complementarity effects among different sets of innovative practices and output. The firms' payoff in innovation by the dummy variable capturing any tipe of innovation could be higher for firms than only one type of innovation (product or process). But what we are really interested in, in particular at this stage, is if firms can benefit in terms of innovation by adopting internationalization strategies. For this reason, we adopt such "funnel approach" moving from a more comprehensive variable (Innov), to more specific types of innovation (product and process).

[19] In Table 8 and in Table 9, we present in columns (1), (2), and (3) the average marginal effects calculated at the means and in columns P.P.(1), P.P.(2) and P.P.(3) the predicted probabilities of a positive outcome. It is worth highlighting that the coefficients may depend on the size of the variable and its variance. So to ensure a better comparison among them, (on the helpful hint of the referee) we are implementing the calculation of standardized betas. However, it must be said that the usual argument for using standardized coefficients is that they provide a means for comparing the effects of variables measured in different metrics but there is a still ongoing debate on the utility of thinking about a one SD increase in a dummy variable and even for continuous variables, standardized coefficients are not very intuitive. Moreover, we already started implementing a test of difference across parameters using the Paternoster (1998) test to look, also, at the differences between two regression coefficients across samples. For the sake of brevity, we do not show the results for the sector and region.

the foreign direct investors show a positive although weak coefficient, and if we consider the estimation for outsourcing, in this case we have a positive and also significant coefficient. The average number of employees matters, confirming that bigger firms are more likely innovators and also the coefficient of the R&D variable is, as expected, positive and significant since investing in R&D activities has a positive outcome on innovation, whereas acquiring patents from abroad has a negative impact on innovation.

The three strategies considered have a positive return in terms of innovation: these results, instead, seem to confirm the LIBE hypothesis, since firms that export are more likely innovators in the subsequent period. Moreover, the FDI coefficient confirms the hypothesis that firms investing abroad have a return in terms of knowledge enhancing their innovation activity; finally, the positive (even if not significant) coefficient of outsourcing suggests that also this strategy can have a positive impact on innovation performance. Looking at the other results, we can assert that the size of the firms matters: the bigger is the firm the higher is the probability of introducing innovation.

Table 9 - Probit estimation results for product innovation

	(1)	P.P.(1)	(2)	P.P.(2)	(3)	P.P.(3)
Export	0.313*** (0.079)	(0.105)				
FDI			0.217 (0.207)	(0.073)		
Outsourcing					0.205** (0.092)	(0.069)
lage	0.024 (0.080)	(0.008)	0.015 (0.082)	(0.005)	0.013 (0.082)	(0.004)
_isgruppo	0.041 (0.085)	(0.014)	0.029 (0.087)	(0.009)	0.029 (0.087)	(0.01)
_capintensity	-0.002*** (0.001)	(-0.001)	-0.002*** (0.001)	(-0.001)	-0.002** (0.001)	(-0.001)
_VAempl	2.37e-06 (1.65e-06)	(7.99e-07)	3.06e-06* (1.69e-06)	(1.03e-06)	2.97e-06* (1.70e-06)	(1.00e-06)
_hares	0.656*** (0.077)	(0.221)	0.713*** (0.079)	(0.240)	0.686*** (0.079)	(0.23)
_sogestr_ctrl	-0.056 (0.146)	(-0.019)	-0.057 (0.151)	(-0.019)	-0.052 (0.150)	(-0.017)
_patents	0.001 (0.222)	(0.001)	0.017 (0.228)	(0.006)	-0.029 (0.229)	(-0.009)
dimension (n. empl.)						
20-49	0.105 (0.0833)	(0.036)	0.124 (0.085)	(0.043)	0.127 (0.085)	(0.043)
50-249	0.220** (0.093)	(0.076)	0.254*** (0.094)	(0.088)	0.261*** (0.095)	(0.089)
>=250	0.488*** (0.143)	(0.168)	0.532*** (0.147)	(0.184)	0.538*** (0.147)	(0.185)
Industry	(Yes)		(Yes)		(Yes)	
Region	(Yes)		(Yes)		(Yes)	
No. firms	1.989		1.992		1.996	

Standard errors in brackets; * p<0.1; ** p<0.05; *** p<0.01.
Source: own calculation. Industry and region dummies included. In columns (1), (2), and (3), the average marginal effects calculated at the means are displayed. Predicted Probabilities in column P.P.

technological based activities keeping their core activities, more technology-led, in home plants.
If we shift the focus on product innovation as a measure of innovation (Table 9), the FDI turns to be not significant (while it was significant for innovation of any type), while the coefficient of exports is still positive and significant. The outsourcing strategy, in this case, has a positive and significant coefficient as in the previous estimation.

4.2 Second step: PROPENSITY SCORE ESTIMATION

In order to avoid the selection effect into foreign market entry, one possible solution may be the matching approach that allows to overcome this problem correcting for sample selection bias due to differences on observable characteristics between the group of firms that has undertaken any internationalization strategy (treatment group) and the group that has not (control group).
The aim of propensity score matching technique is to pair firms receiving the treatment on the basis of some observable variables with firms not receiving the treatment on the basis of a score defined as the probability that a unit in the full sample receives the treatment, given a set of observed variables. If we consider all the variables that are relevant to participation and outcomes, the propensity score will produce valid matches for estimating the impact of an intervention allowing to compare individuals on the basis of their propensity scores alone.

Given the variety of firm observables (productivity, size, ownership, industry and time effects) that could potentially serve as a basis for matching, the dimensionality problem arises. The problem of having too many possibilities for matching (too many dimensions) can be resolved by applying propensity score-matching (Rosenbaum and Rubin, 1983), which uses the probability of receiving a given treatment, conditional on the pre-entry characteristics of firms, to reduce the dimensionality problem.

Assuming that the selection of firms is completely based on observed variables and the assignment is random, it is possible to compute the propensity score, i.e. the probability to participate to the treatment conditioning to the pre-treatment control variables (e.g. Exporting firms are matched with individual firms that do not export based on an estimated probability that the firm would export (the propensity score), hence it requires selection on observables and the existence of an untreated firm that can be compared to a treated firm). Finally, comparing treated with non-treated - with the same propensity score - it is possible to estimate the average treatment effect on the treated (ATT)[20].

In order to implement this kind of setting, is fundamental to identify those that Caliendo et al. (2008) identify as the main pillars: the individuals (in our case are the Italian firms), the treatment (the internationalization strategy) and the potential outcome (the innovation performance).

This matching methodology has been applied by several authors with different aims, since economic application s of matching estimators have been growing in recent years: there are works

[20] For a more detailed description on how the methodology works, see Appendix A2.

investigating the effect of policy intervention on labour market (Heckman et al. 1997, Blundell et al. 2002); the effect of the FDI on firm's domestic activity (e.g., Navaretti et al., 2010) and on employment (Bronzini, 2015). Furthermore, other papers investigate the relationship between internationalization strategies and firm performance measured in different ways by using PSM: export and productivity (Girma et al., 2004 and, for a review, Greenaway and Kneller, 2007); export, import and innovation (Damijan, Kostevc 2015).

In our case, we implement a probit propensity score matching estimation in which, as said, the treatment is represented by the internationalization status in the previous period and the outcome is the innovation performance measured as the introduction of any type of innovation and the set of control variables is the same we used for probit estimation.

Another important choice in the implementation of this setting is to choose the matching algorithm. All matching algorithms pair the outcome of a treated individual with outcomes of comparison group members and they differ not only in the way the neighborhood for each treated individual is defined and the common support problem is handled, but also with respect to the weights assigned to these neighbors.

There are different techniques to face this problem but, in order to ensure the quality of the matching, we use a nearest neighbor matching (1-to-1 matching with replacement[21]) strategy and we

[21] Even if the "with replacement" strategy could lead to some estimation problems, because it could pair different internationally active active firms with the same non-internationally active one, if we chose the "without replacement" strategy, it could have increased the variance, giving problems of common support.

restrict the sample to the common support area by using a caliper of 0.01[22].

The probit equations we estimate are the same as that in [Equations 1] but in order to control for the time effects, we add a time dummy variable identifying the waves (*i.time*).

In the Table 10, we present the results of the three different matching estimations, measuring the ATT[23].

Table 10- The impact of internationalization on innovation (ATT)

Internationalization strategy	ATT	SE	Number of treated	Number of controls
Export	0.116**	0.0476	1.350	588
FDI	0.259***	0.094	54	1.480
Outsourcing	0.056	0.042	320	1.655

Nearest neighbour matching (n=1), with replacement, caliper (0.01).
* p<0.1; ** p<0.05; *** p<0.01.

Firms exporting in the previous period seem to have a 11,6% higher probability of introducing innovation in the subsequent period with respect to their non-exporting counterparts and an even higher probability is shown by the firms that have

[22] Different calipers ranging from 0.15 to 0.3 were tested without significant different in outcomes.

[23] After calculating propensity scores matching, we test whether the assumption of conditional independence is satisfied in our different specifications. As robustness check, find in the Appendix A3 the results of PSM estimation and in the Appendix A4 are shown the results of the PSM with kernel.

implemented a FDI strategy (25,9%). The outsourcing strategy, instead, ensures the lowest probability of innovating (5.6%).
The results are in line with the ones from probit, and, moreover, they confirm the LIBE hypothesis since exporting has a positive impact on innovation and this could be explained by the ability of the firms in assimilating knowledge spillovers from foreign markets and economies.
Also the FDI show a positive, even grater, impact on innovation. This could mean that the firms in our sample may be able to take advantage of having direct access to peculiar knowledge available in other countries and this access to knowledge allows firms to gain advantage with respect to non-investing firms.
Conversely, the not significant results shown by the firms that are involved in outsourcing seems to confirm that this type of internationalization strategy could ensure only some kinds on innovation, but it is not always a secure tool to innovate. This strategy, indeed, could even replace internal R&D investment making firms loose touch with the most recent advantages in technology.
From a policy perspective, finally, in order to spur the innovation performance of the firms, it seems more profitable to implement programs that stimulate FDI and export, rather than outsourcing.
As in the other estimation procedures, if we consider the product innovation as measure of innovation, the results shown in Table 11 are pretty much the same. Also in this case, exporting and FDI show (with almost similar coefficient) positive possibility, and it is greater compared to outsourcers, of introducing product innovation.

Table 11 - The impact of internationalization on product innovation (ATT)

Internationalization strategy	ATT	SE	Number of treated	Number of controls
Export	0.16***	0.0456	1.350	588
FDI	0.166*	0.1002	54	1.480
Outsourcing	0.053	0.043	320	1.655

Nearest neighbour matching (n=1), with replacement, caliper (0.01).
* p<0.05; ** p<0.01; *** p<0.001.

If we consider the process innovation (Table 12), instead, FDI is the strategy that ensures the higher positive probability of introducing innovation. But all the strategies loose their significance.

Table 12 - The impact of internationalization on process innovation (ATT)

Internationalization strategy	ATT	SE	Number of treated	Number of controls
Export	-0.038	0.033	1.350	588
FDI	0.074	0.0943	54	1.480
Outsourcing	0.05	0.038	320	1.655

Nearest neighbour matching (n=1), with replacement, caliper (0.01).
* p<0.05; ** p<0.01; *** p<0.001.

5. The innovation race: do the destinations affect the outcome?

Another purpose we want to achieve is to understand if the destination of exporting, investing or outsourcing may have some effects on the innovation performance.

It could be relevant, indeed, to control for the type of destination of the international activities since, for example, exporting (investing, outsourcing) towards more technologic-demanding markets might spur the firm's innovation activity or exporting to more competitive markets may involve greater innovation efforts (Girma et al. 2008).

Previous studies, indeed, have found that productivity improvements due to learning will be higher if the destination countries are highly developed and exporting firms have to compete with or supply firms that operate next to the technological frontier (Wagner, 2012). Positive productivity effects of exporting (learning-by-exporting) can be expected to differ between (groups of) destination countries.

If, on one hand, different foreign markets require specific R&D investments since the destination of exports modifies the set of determinants of firm's performance (Lefebvre et al. 1998) on the other, productivity improvements due to learning will be higher according to the number of markets served (Castellani et al., 2010) if the destination countries are highly developed and exporting firms have to compete with or supply to firms that operate next to the technological frontier and use the latest vintage of capital goods and best practices in management to produce innovative products.

Also the distance of the served makes matters: Alarcón and Sanchez (2016) find different effects for Spanish food companies according to the destination served: exporting outside the EU, towards more distant countries could need more time to assimilate positive knowledge spillover.

However, evidence for different effects of exporting on productivity, and more specifically on innovation, by destination of exports is rare and not conclusive and our work is supposed to add evidence on this topic.

From the data at our disposal, we can draw information about the destination of exporting, investing or outsourcing so we can split the firms' in the sample in three different categories according to the destination country of activity (EU 15[24]; non-European industrialized countries; non-European non industrialized countries).

Table 13 - Strategies/destination

Internationalization strategy	**Export**	**FDI**	**Outsourcing**
EU 15	95.8% (8154)	30.33% (74)	68.8% (930)
Non-Ue Industrialized	63.63% (4913)	52.87% (129)	52.42% (716)
Non-Ue non Industrialized	57.35% (3.193)	25.53% (72)	12.09% (209)

[24] Member countries in the European Union prior to the accession of ten candidate countries on 1 May 2004: Austria, Belgium, Denmark, Finland, France, Germany, Greek, Ireland, Luxembourg, Netherlands, Portugal, UK, Spain, Sweden.

Looking at Table 13, we can see that almost all exporting firms has exported towards EU 15 countries whereas most of FDI are towards non European industrialized countries. The 68.8% of the firms in the sample, instead, conclude outsourcing agreements with partners in the EU15 countries. As expected, non European and non industrialized countries are the less chosen option for investments and outsourcing, since production benefits that could come from less developed economies are presumably weaker than the ones coming from more advanced countries.

If we apply the same propensity score matching strategies as before considering the destinations[25], we can see (Table 14) that, if we consider the introduction of any type of innovation, exporting firms benefit in terms of innovation from exporting towards non-European and non-industrialized countries. International firms investing abroad, instead, seem to have higher benefits from investing in countries that are not in the EU15 classification. This could be explained by the fact that these firms benefit from knowledge spillovers coming from developed different and distant economies (e.g. USA, Canada, etc) more than from more similar economies as the ones in the EU area. Outsourcing, instead, does not show significant coefficients in any case confirming that the return in terms of innovation associated to this strategy is weaker.

[25] See the Appendix A6 for the results obtained using kernel matching algorithm.

Table 14 - Strategies/Destinations (PSM) for any type of innovation

		EU 15		
Internationalization strategy	**ATT**	**SE**	**Number of treated**	**Number of controls**
Export	0.153	0.146	736	41
FDI	-0.05	0.14	20	1055
Outsourcing	0.052	0.048	211	1736
	NON EU INDUSTRIALIZED			
	ATT	**SE**	**Number of treated**	**Number of controls**
Export	0.062*	0.037	919	1067
FDI	0.206*	0.114	29	1224
Outsourcing	0.07	0.054	157	1752
	NON EU NON INDUSTRIALIZED			
	ATT	**SE**	**Number of treated**	**Number of controls**
Export	0.171**	0.07	597	309
FDI	-0.0769	0.199	13	897
Outsourcing	-0.021	0.101	47	1616

Nearest neighbour matching (n=1), with replacement, caliper (0.01).
* p<0.1; ** p<0.05; *** p<0.01.

Going into much detail, considering the different types of innovation we considered so far (product and process) (Table 15), the results show that exporting towards non-European less developed countries rewards more in terms of product innovation with respect to other destinations.

If we consider the investments abroad in the case of product innovation, the results are pretty similar since implementing a foreign direct investment in non-European less developed countries ensures an higher reward for product innovativeness. Firms investing in non-European developed economies, instead, has an higher probability of introducing process innovations, since they could benefit from acquiring knowledge about the optimization of the production process that is not available in the domestic or in the European market.

Outsourcing strategy, instead, ensures quite similar returns in terms of probability of introducing process innovation if the deals are made with European or non-European countries, but the same does not hold if we consider product innovation since, in this case, only outsourcing with non-European countries guarantees a positive probability of introducing innovation.

However, in terms of significance, only exporting towards less industrialized countries seems to ensure gains in product innovation. Even if this result may seem surprising and puzzling, it could suggest that Italian firms have to face greater consumer heterogeneity in less-developed countries than in more developed ones, since Italian customers have more similar tastes to customers from developed countries so firms have to modify their products to meet foreign tastes (Salomon, 2006).

Table 15 - Strategies/Destinations (PSM) product and process innovation

	Product Innovation				Process Innovation			
				EU 15				
Intern. strategy	**ATT**	**SE**	**N. of treat.**	**N. contr.**	**ATT**	**SE**	**N. of treat.**	**N. contr.**
Export	0.1155	0.1542	736	41	0.084	0.1555	736	41
FDI	-0.2	0.149	20	1055	0.05	0.1397	20	1055
Outsourcing	-0.0094	0.05	211	1736	0.0189	0.0433	211	1736
				NON EU INDUSTRIALIZED				
	ATT	**SE**	**N. of treat.**	**N. contr.**	**ATT**	**SE**	**N. of treat.**	**N. contr.**
Export	0.047	0.0373	919	1067	0.016	0.028	919	1067
FDI	0.1379	0.128	29	1224	0.17	0.11	29	1224
Outsourcing	0.0318	0.058	157	1752	0.019	0.053	157	1752
				NON EU NON INDUSTRIALIZED				
	ATT	**SE**	**N. of treat.**	**N. contr.**	**ATT**	**SE**	**N. of treat.**	**N. contr.**
Export	0.154**	0.0717	597	309	0.000	0.069	597	309
FDI	0.308	0.2125	13	897	0.0769	0.199	13	897
Outsourcing	-0.17	0.1046	47	1616	0.000	0.102	47	1616

Nearest neighbour matching (n=1), with replacement, caliper (0.01).
* p<0.1; ** p<0.05; *** p<0.01.

6. Concluding Remarks.

Internationalization and innovation are two crucial firms' business decisions capable of producing competitive advantages against competitors, but the relationship between the two does not always have an unambiguous interpretation since it is not clear the causal relation: which one influences the other or whether this could be bi-directional. Our work wants to contribute to the learning by exporting stream of literature, and more specifically to the learning to innovate by exporting, since evidence is relatively recent and poor. Going a step further, we look at three different internationalization strategies and we find that the lagged status of internationalization has a different impact on innovation (and product innovation) according to the strategy chosen. Looking at the preliminary descriptive statistics, our sample confirms a widely empirically supporting evidence: firms involved in internationalization strategies are bigger, more productive than firms that do not enter foreign market (Aw et al. 2000; Bernard and Jensen 1999; Clerides et al.1998; Greenway and Kneller 2007). What comes out from our analysis is that it is possible to suppose a hierarchy among the different strategies considered, in terms of innovation that firms can improve with respect to their counterparts not implementing the same strategy: FDI is the strategy ensuring the higher return in terms of innovation of any type, while exporting in the case of product innovation. On the contrary, outsourcing in both cases is the less rewarding strategy.

To our purpose, indeed, we use, at a first stage, a random effect probit estimation and then a propensity score matching procedure and the Heckman correction to control for endogeneity and selection bias. The results show that exporting

has a positive impact on innovation (as in several previous studies, e.g. Salomon and Shaver, 2005; Criscuolo, 2010; Accetturo et al. 2014; Damijan et al. 2015) and so does the FDI strategy, if any type of innovation is considered. The literature has found positive effects of the latter strategy on innovation since it may allow firms to gain access to new technologies augmenting or complementing firms' existing knowledge stock (Quinn, 2000; Chung and Yeaple, 2008). We moreover consider the outsourcing strategy and, also in this case, despite some lack of significance, it seems to have a positive impact on innovation. We also use a product innovativeness as in other previous works (e.g. Bratti and Felice 2012, who consider complementarities with process innovation), because some recent empirical studies evidence that product innovation may generate positive returns at the firm level, on sales, employment (Hall et al., 2008) and – in some cases – on productivity (Crépon et al., 1998). Moreover, even if this kind of indicator may have a more subjective nature than others used in literature (patents, R&D expenditure, etc.) it is useful because it is an output measure of innovation capturing the innovations that are carried out without being patented (Bratti and Felice, 2012).

The results obtained considering the product innovation confirm the positive effect of exports and FDIs on firms' innovative performance and the non-significant impact of outsourcing. However, in the PSM but with kernel, the stronger positive impact of exporting, rather than FDI, suggest that exporting firms has to meet consumers' tastes across countries because of cultural, geographic, ethnic and historical differences and this may represent an important incentive for firms that do export to introduce product innovations to differentiate them from foreign competitors and find a market niche to position itself (Bratti and Felice, 2012).

When we look at the results of PSM estimation for process innovation, instead, FDI looses significance and positive and significant returns are proved only for outsourcing when we use Heckman's procedure suggesting that firms could modify their production processes, even through some adjustments, to optimize the production chain .

Another important contribution of our work is to consider how exporting, investing or outsourcing in different countries may affect the innovation outcome.

Previous studies, indeed, have found that productivity improvements due to learning will be higher if the destination countries are highly developed and exporting firms have to compete with or supply firms that operate next to the technological frontier (Wagner, 2012). Positive productivity effects of exporting (learning-by-exporting) can be expected to differ between (groups of) destination countries. Productivity improvements due to learning will be higher according to the number of markets served (Castellani et al., 2010) if the destination countries are highly developed and exporting firms have to compete with or supply to firms that operate next to the technological frontier and use the latest vintage of capital goods and best practices in management to produce innovative products.

Also the distance of the served makes matters: Alarcón and Sanchez (2016) find different effects for Spanish food companies according to the destination served: exporting outside the EU, towards more countries could ask more time to assimilate positive knowledge spillover.

The most relevant result of our study about the relationship markets served/innovation performance is that firms that export in non-industrialized countries may benefit in terms of innovation more than firms that export in more developed

countries. Even if it is not possible to exclude completely the possibility that product innovation take the form of little modification to simplify the products or to reduce their quality, this could lead to reducing costs and quality to sell to lower-income customers, our results, in steps with those of Salomon (2006) on Spanish firms, may suggest that Italian firms in order to face the greater tastes' heterogeneity of consumers from less-developed countries, have to put a great deal of effort to tailor their products to match foreign consumer tastes.

Appendix.

A1: Construction of the dataset.

As said in section 3, we consider firm level data on Italian firms drawn on three wave of a survey: from the 8th (1998-2000) and 9th (2001-2003) Capitalia Survey of Manufacturing firms (Indagine sulle imprese manifatturiere, SIMF or Capitalia Survey) managed by the Capitalia banking group (formerly Mediocredito Centrale and now member of the UniCredit Group) and on the X-Wave (2004-2006) of the Capitalia-UniCredit survey. We also merge the three waves and this gives us an unbalanced panel of 19.617 observations.

The data at our disposal were initially divided in three different datasets: one for each wave. The VIII wave, referring to the years 1998-2003 contained a total amount of 4.680 observations; a second dataset containing the IX Wave (2001-2003) with 4289 observations and the Xth Wave[26] (covering years 2004-2006) with 5.137 observations.

Table A1 - Description of the different waves of the surveys.

Wave	obs.	Variables
1998-2000	4680	381
2001-2003	4289	727
2004-2006	5137	1.116
Estimation Panel	14.106	3808

[26] It is worth saying that in the 10th Wave of the survey, the population has been partially resampled through the

The merging procedure has been carried out considering as identification variable in order to pair for different periods the observations for the same firms.
The variables collected in the first dataset come from the answers the firms have given to the questionnaires and over the different waves of the survey the questions have been maintained as much constant as possible, in order to make the data comparable over time.
The questions are in some cases dichotomous and in some others very detailed; sometimes they refer to the three-year period, but other times only to the last year observed.

Table A2 - Internationalization strategies by waves

	VIII Wave		**IX Wave**		**X Wave**		**Estimation Panel**	
	Yes	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
Export	**66.73 %** (3.123)	**33.27 %** (1.557)	**74.72 %** (3.175)	**25.28 %** (1.074)	**61.99 %** (3.164)	**38.01 %** (1.940)	**67.43 %** (9.462)	**32.57 %** (4.571)
FDI	**2.14%** (100)	**97.86 %** (4.580)	**3.49%** (144)	**96.51 %** (3.981)	**13.92 %** (38)	**86.08 %** (235)	**3.11%** (282)	**96.89 %** (8.796)
Outsourcing	**11.5%** (538)	**88.5%** (4.142)	**7.54%** (313)	**92.46 %** (3.838)	**7.05%** (362)	**92.95 %** (4.775)	**5.59%** (781)	**25,81 %** (13.187)

Frequencies in parenthesis.
Source: own calculation

introduction of 4.088 firms, keeping 1.049 firms from the previous wave. Source: UniCredit - "Decima indagine sulle imprese manifatturiere italiane" - Rapporto Corporate N.1 2008.

To these data, we appended balance sheet data gathered in three different dataset containing detailed information on capitalization, debt exposure, sales and revenues, etc.

Table A3 - Variables description by period

	1998-2000			2001-2003			2004-2006		
Variable	**Obs**	**Mean**	**Std. Dev.**	**Obs**	**Mean**	**Std. Dev.**	**Obs**	**Mean**	**Std. Dev.**
innov	4624	0,538	0,4985865	4156	0,4205967	0,4937143	4848	0,6650165	0,4720334
innovprod	4624	0,253	0,4346708	4156	0,4205967	0,4937143	4848	0,5195957	0,4996674
ha_expor	4680	0,667	0,4712277	4249	0,7472346	0,4346487	5104	0,619906	0,4854572
FDI	4680	0,021	0,1446216	4125	0,0349091	0,1835718	273	0,1391941	0,3467847
outsourcing	4680	0,011	0,3190044	4151	0,0754035	0,2640731	5137	0,0704691	0,2559609
lage	4643	3,602	0,37919	4115	3,623	0,418	5061	3,482	0,524
isgroup	4671	0,204	0,402873	4280	0,324	0,468	5094	0,193	0,395
capintensity	4000	43,094	89,598	939	0,254	4,570	4731	303,88	1133,05
VAempl	4020	41873,7	23809,6	1004	65466,7	120958	4656	83285,3	470113
hares	4603	0,376	0,485	4171	0,460	0,498	4841	0,557	0,497
sogestr_ctrll	4680	0,053	0,225	4289	0,075	0,264	5137	0,031	0,172
patents	4599	0,018	0,132	4144	0,023	0,151	5048	0,008	0,089

Source: own calculation

For what concerns the variables we used, our unbalanced estimation panel seems to keep all the informations contained in the different waves and to be fairly representative of the these as shown in the Table A2, Table A3, and Table A4.

Table A4 - Variables description by period.

	1998-2000		2001-2003		2004-2006		Estimation Panel	
Variable	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
innov	2135 (46.17)	2489 (53.83)	2408 (57.94)	1748 (42.06)	1624 (33.5)	3224 (66.50)	6167 (45.25)	7461 (54.75)
innov	3455 (74.72)	1169 (25.28)	2408 (57.94)	1748 (42.06)	2329 (48.04)	2519 (51.96)	8192 (60.11)	5436 (39.89)
ha_expor	1557 (33.27)	3123 (66.73)	1074 (25.28)	3175 (74.72)	1940 (38.01)	3164 (61.99)	4571 (32.57)	9462 (67.43)
FDI	4580 (97.87)	100 (2.14)	3981 (96.51)	144 (3.49)	16 (43.24)	21 (56.76)	8796 (96.89)	282 (3.11)
outsourcing	4.142 (88.5 %)	538 (11.5 %)	3839 (92.46)	313 (7.54)	4775 (92.95)	362 (7.05)	13187 (94.41)	781 (5.59)
isgroup	3719 (79.62)	952 (20.38)	2894 (67.72)	1386 (32.38)	4109 (80.66)	985 (19.34)	10722 (76.34)	3323 (23.66)
hares	2871 (62.73)	1732 (37.63)	2254 (54.04)	1917 (45.96)	2143 (44.27)	2698 (55.73)	7268 (53.38)	6347 (46.62)
sogestr_ctrl	4430 (94.66)	250 (5.34)	3967 (92.49)	322 (7.51)	4980 (96.94)	157 (3.06)	13377 (94.83)	729 (5.17)
patents	4518 (98.24)	81 (1.76)	4047 (97.66)	97 (2.34)	5008 (99.21)	40 (0.79)	13573 (98.42)	218 (1.58)

Percentages in parenthesis.

A2: Matching procedure.

The key idea of the Propensity score matching is that the impact of a treatment on an individual *i*, δi, is given by the difference between potential outcomes with (Y_1) and without treatment (Y_0):

$$\delta i = Y_{1i} - Y_{0i}$$

Nevertheless, in this case, the fundamental problem of causal inference arises since it is impossible to observe the outcomes of the same unit in both treatment and non treatment conditions at the same time.

Then, in order to evaluate the impact of a program over our population, we may compute the average treatment effect (ATE):

$$ATE = E[\delta_i] = E(Y_1 - Y_0)$$

Most often, if we indicate with (D=1) the participation to the treatment, we want to compute the average treatment effect on the treated (ATT) :

$$ATT = E(Y_1 - Y_0 | D = 1)$$

that could be rewritten as:

$$ATT = E(Y_1 | D=1) - E(Y_0 | D=1)$$

However, the second term is the average outcome of treated individuals if they had not received the treatment. It is

unobservable, we need to use a corresponding quantity for the untreated, and can compute

$$\Delta = E(Y_1 | D = 1) - E(Y_0 | D = 0)$$

The difference between the Δ quantity we calculate and the ATT is the selection bias that could be zero in order to make our Δ valid.

To this aim, the PSM basically relies on the very strong assumption of Conditional Independence (CIA) that assumes that selection is solely based on observable characteristics and that all variables that influence treatment assignment and potential outcomes simultaneously are observed and once we control for these covariates, the potential outcomes are independent of treatment status.

$$(Y_1, Y_0) \perp D | X$$

Another important assumption (Common support) is that, considered the covariates, there is a positive
probability of being both treated and untreated:

$$0 < P(D = 1 | X) < 1$$

If these two assumptions hold, we can use the (observed) mean outcome of the non-treated to estimate the mean (counterfactual) outcome the treated would have had they not been treated.

Assuming that the assumption holds, the fundamental subsequent steps are about two choices: the model to use for the estimation of the PS and the variables to be included.

For what concerns the choice of the model, in principle any discrete choice model could be used, but there is a sort of preference for probit (or logit, the two models lead to similar results specially in the binary treatment case) models given the well-known shortcomings of the linear probability models.
Regarding the variable choice, instead, since, as said, the matching procedure relies on the CIA, the outcome variable should be independent of the treatment conditional on propensity score. Implementing matching techniques, indeed, requires choosing a set of X that credibly satisfies this condition since omitting important variables can increase bias in resulting estimates.
Hence, after controlling for several observables, the selection into the internationalization of the firm "looks" random and the potential outcomes are independent of the treatment status.

A3: Matching balancedness check.

It can be seen that, in our cases, matching with nearest neighbor and caliper (0.01) substantially reduces the bias in most of the cases. Furthermore, a comparison of pseudo-R2 of the propensity score estimation before and after matching reveals a significant reduction in the explanatory power of these variables.

Table A5 - Balancing property - Export strategy on innovation.

Variable	Unm. vs Match.	Mean Treated Control	%bias	%reduct bias	t-test t p>t	V(T)/ V(C)
lage	U	3.6656 3.6341	7.7		1.53 0.126	1.35*
	M	3.6656 3.7222	-13.9	-79.9	-3.33 0.001	0.95
_isgruppo	U	.26948 .18027	21.5		4.25 0.000	1.33*
	M	.25407 .2	13.0	39.4	3.36 0.001	1.18*
_capintensity	U	26.705 31.603	-7.8		-1.69 0.092	0.59*
	M	26.482 29.432	-4.7	39.8	-1.37 0.171	0.86*
_VAempl	U	47951 41596	30.2		5.99 0.000	1.29*
	M	47212 46708	2.4	92.1	0.59 0.553	0.88*
_hares	U	.52323 .19898	71.7		13.97 0.000	1.56*
	M	.50593 .50222	0.8	98.9	0.19 0.847	1.00
_sogestr_ctrl	U	.06505 .03231	15.2		2.92 0.004	1.94*
	M	.05556 .03259	10.7	29.8	2.91 0.004	1.66*
_patents	U	.02931 .0051	18.7		3.35 0.001	5.60*
	M	.02 .00963	8.0	57.2	2.23 0.026	2.06*
2.dim	U	.32237 .38946	-14.0		-2.88 0.004	0.92
	M	.33259 .31852	2.9	79.0	0.78 0.435	1.02
3.dim	U	.33881 .18878	34.5		6.77 0.000	1.46*
	M	.33704 .33185	1.2	96.5	0.29 0.775	1.01
4.dim	U	.11794 .03571	31.2		5.79 0.000	3.02*
	M	.10148 .10815	-2.5	91.9	-0.57 0.572	0.95
Pseudo R^2 (UM)			0,187			
Pseudo R^2 (M)			0,041			

Source: own calculation

* if variance ratio outside [0.90; 1.11] for U and [0.90; 1.11] for M

Table A6 - Balancing property - FDI strategy on innovation.

Variable	Unm. vs Matc h.	Mean Treated Control	%bias	%reduc t bias	t-test t p>t	V(T)/V (C)
lage	U	3.7655 3.6474	25.2		2.13 0.034	1.66
	M	3.735 3.6524	17.6	30.0	0.97 0.334	1.95*
_isgruppo	U	.57895 .21622	79.4		6.47 0.000	1.46
	M	.55556 .55556	0.0	100.0	0.00 1.000	1.00
_capintensity	U	25.147 26.782	-3.1		-0.23 0.818	0.95
	M	25.815 29.292	-6.7	-112.7	-0.36 0.719	1.23
_VAempl	U	47054 44812	11.3		0.84 0.404	1.01
	M	46752 44882	9.4	16.6	0.49 0.625	1.11
_hares	U	.70175 .41959	59.0		4.24 0.000	0.87
	M	.68519 .66667	3.9	93.4	0.20 0.839	0.97
_sogestr_ctrl	U	.07018 .04459	11.0		0.91 0.364	1.56
	M	.07407 .03704	15.9	-44.8	0.84 0.406	1.92*
_patents	U	.07018 .02095	23.6		2.45 0.014	3.24*
	M	.07407 .05556	8.9	62.4	0.39 0.699	1.31
2.dim	U	.22807 .36284	-29.7		-2.08 0.037	0.77
	M	.24074 .46296	-49.0	-64.9	-2.46 0.015	0.74
3.dim	U	.36842 .29324	16.0		1.22 0.223	1.14
	M	.38889 .22222	35.4	-121.7	1.89 0.061	1.37
4.dim	U	.33333 .07568	67.0		6.94 0.000	3.23*
	M	.2963 .27778	4.8	92.8	0.21 0.833	1.04
Pseudo R^2 (UM)			0,195			
Pseudo R^2 (M)			0,183			

Source: own calculation

* if variance ratio outside [0.90; 1.11] for U and [0.90; 1.11] for M

Table A7 - Balancing property - Outsourcing strategy on innovation

Variable	Unm. vs Match.	Mean Treated	Control	%bias	%reduct bias	t-test t	p>t	V(T)/ V(C)
lage	U	3.6638	3.6568	1.6		0.28	0.782	1.31*
	M	3.6616	3.6723	-2.5	-53.0	-0.31	0.758	1.22
_isgruppo	U	.33538	.22477	24.8		4.27	0.000	1.28*
	M	.33642	.32102	3.5	86.1	0.42	0.677	1.02
_capintensity	U	23.325	28.837	-10.5		-1.54	0.123	0.44*
	M	23.295	23.821	-1.0	90.4	-0.15	0.884	0.68*
_VAempl	U	50426	45268	23.6		3.92	0.000	1.04
	M	50408	50254	0.7	97.0	0.09	0.932	0.89
_hares	U	.72615	.36858	76.9		12.36	0.000	0.86
	M	.72531	.73312	-1.7	97.8	-0.22	0.823	1.02
_sogestr_ctrl	U	.08615	.04894	14.9		2.69	0.007	1.70*
	M	.08642	.08357	1.1	92.3	0.13	0.897	1.03
_patents	U	.06462	.01329	26.7		5.85	0.000	4.62*
	M	.06173	.05184	5.2	80.7	0.54	0.587	1.18
2.dim	U	.30154	.34985	-10.3		-1.68	0.093	0.93
	M	.30247	.29357	1.9	81.6	0.25	0.805	1.02
3.dim	U	.34154	.28701	11.8		1.97	0.049	1.10
	M	.33951	.36031	-4.5	61.9	-0.55	0.580	0.97
4.dim	U	.18154	.07613	31.8		6.02	0.000	2.12*
	M	.1821	.17179	3.1	90.2	0.34	0.731	1.05
Pseudo R^2 (UM)				0,132				
Pseudo R^2 (M)				0,004				

Source: own calculation

* if variance ratio outside [0.90; 1.11] for U and [0.90; 1.11] for M

Table A8 - Balancing property - Export strategy on product innovation.

Variable	Unm. vs Matc h.	Mean Treated Control	%bias	%reduc t bias	t-test t p>t	V(T)/V (C)
lage	U	3.6656 3.6341	7.7		1.53 0.126	1.35*
	M	3.6656 3.7222	-13.9	-79.9	-3.33 0.001	0.95
_isgruppo	U	.26948 .18027	21.5		4.25 0.000	1.33*
	M	.25407 .2	13.0	39.4	3.36 0.001	1.18*
_capintensity	U	26.705 31.603	-7.8		-1.69 0.092	0.59*
	M	26.482 29.432	-4.7	39.8	-1.37 0.171	0.86*
_VAempl	U	47951 41596	30.2		5.99 0.000	1.29*
	M	47212 46708	2.4	92.1	0.59 0.553	0.88*
_hares	U	.52323 .19898	71.7		13.97 0.000	1.56*
	M	.50593 .50222	0.8	98.9	0.19 0.847	1.00
_sogestr_ctrl	U	.06505 .03231	15.2		2.92 0.004	1.94*
	M	.05556 .03259	10.7	29.8	2.91 0.004	1.66*
_patents	U	.02931 .0051	18.7		3.35 0.001	5.60*
	M	.02 .00963	8.0	57.2	2.23 0.026	2.06*
2.dim	U	.32237 .38946	-14.0		-2.88 0.004	0.92
	M	.33259 .31852	2.9	79.0	0.78 0.435	1.02
3.dim	U	.33881 .18878	34.5		6.77 0.000	1.46*
	M	.33704 .33185	1.2	96.5	0.29 0.775	1.01
4.dim	U	.11794 .03571	31.2		5.79 0.000	3.02*
	M	.10148 .10815	-2.5	91.9	-0.57 0.572	0.95
Pseudo R^2 (UM)			0,187			
Pseudo R^2 (M)			0,041			

Source: own calculation
* if variance ratio outside [0.90; 1.11] for U and [0.90; 1.11] for M

Table A9 - Balancing property - FDI strategy on product innovation.

Variable	Unm. vs Match.	Mean Treated Control	%bias	%reduct bias	t-test t p>t	V(T)/V(C)
lage	U	3.7655 3.6474	25.2		2.13 0.034	1.66
	M	3.735 3.6524	17.6	30.0	0.97 0.334	1.95*
_isgruppo	U	.57895 .21622	79.4		6.47 0.000	1.46
	M	.55556 .55556	0.0	100.0	0.00 1.000	1.00
_capintensity	U	25.147 26.782	-3.1		-0.23 0.818	0.95
	M	25.815 29.292	-6.7	-112.7	-0.36 0.719	1.23
_VAempl	U	47054 44812	11.3		0.84 0.404	1.01
	M	46752 44882	9.4	16.6	0.49 0.625	1.11
_hares	U	.70175 .41959	59.0		4.24 0.000	0.87
	M	.68519 .66667	3.9	93.4	0.20 0.839	0.97
_sogestr_ctrl	U	.07018 .04459	11.0		0.91 0.364	1.56
	M	.07407 .03704	15.9	-44.8	0.84 0.406	1.92*
_patents	U	.07018 .02095	23.6		2.45 0.014	3.24*
	M	.07407 .05556	8.9	62.4	0.39 0.699	1.31
2.dim	U	.22807 .36284	-29.7		-2.08 0.037	0.77
	M	.24074 .46296	-49.0	-64.9	-2.46 0.015	0.74
3.dim	U	.36842 .29324	16.0		1.22 0.223	1.14
	M	.38889 .22222	35.4	-121.7	1.89 0.061	1.37
4.dim	U	.33333 .07568	67.0		6.94 0.000	3.23*
	M	.2963 .27778	4.8	92.8	0.21 0.833	1.04
Pseudo R^2 (UM)			0,195			
Pseudo R^2 (M)			0,183			

Source: own calculation

* if variance ratio outside [0.90; 1.11] for U and [0.90; 1.11] for M

Table A10 - Balancing property - Outsourcing strategy on product innovation.

Variable	Unmatched Matched	Mean Treated Control	%bias	%reduct bias	t-test t p>t	V(T)/V(C)
lage	U	3.6659 3.6512	3.5		0.50 0.615	1.04
	M	3.6655 3.6609	1.1	68.4	0.11 0.909	0.95
_isgruppo	U	.34783 .22275	27.9		4.20 0.000	1.32*
	M	.33333 .35111	-4.0	85.8	-0.40 0.692	0.98
_capintensity	U	32.925 27.52	10.0		1.29 0.196	0.56*
	M	32.246 35.525	-6.1	39.3	-0.67 0.503	0.59*
_VAempl	U	45947 45780	0.8		0.11 0.911	0.80
	M	45994 49580	-17.5	-2038.1	-1.89 0.059	0.88
_hares	U	.73478 .39218	73.5		10.09 0.000	0.82
	M	.72889 .78667	-12.4	83.1	-1.43 0.153	1.18
_sogestr_ctrl	U	.08696 .04976	14.8		2.34 0.019	1.69*
	M	.08444 .08889	-1.8	88.1	-0.17 0.867	0.95
_patents	U	.06957 .0154	27.1		5.30 0.000	4.28*
	M	.05778 .05778	0.0	100.0	-0.00 1.000	1.00
2.dim	U	.3087 .34953	-8.7		-1.22 0.222	0.94
	M	.31556 .25778	12.3	-41.5	1.35 0.176	1.13
3.dim	U	.3 .29917	0.2		0.03 0.979	1.01
	M	.30222 .32	-3.9	-2043.5	-0.41 0.685	0.97
4.dim	U	.1913 .0782	33.5		5.62 0.000	2.15*
	M	.17778 .20889	-9.2	72.5	-0.83 0.405	0.88
Pseudo R^2 (UM)			0,147			
Pseudo R^2 (M)			0,040			

Source: own calculation
* if variance ratio outside [0.90; 1.11] for U and [0.90; 1.11] for M

A4: Changing the matching algorithm.

If we change the matching algorithm by using kernel, the results are similar to the ones obtained with caliper. The FDI strategy still seems to increase the probability of introducing innovations with respect to exporting and outsourcing. Moreover, the latter shows a negative coefficient, confirming that it may be a trigger strategy. The hierarchy of different strategies is in this case confirmed if we consider product innovation.

Table A11 - The impact of internationalization on innovation (ATT) with caliper of 0.01 and kernel

Internationalization strategy	ATT	SE	Number of treated	Number of controls
Export	0.1074***	0.035	1.350	588
FDI	0.1753***	0.065	57	1.480
Outsourcing	0.060**	0.0305	324	1.655

Nearest neighbour matching (n=1), with replacement, caliper (0.01), and kernel.

Table A12 - The impact of internationalization on product innovation (ATT) with caliper of 0.01 and kernel

Internationalization strategy	ATT	SE	Number of treated	Number of controls
Export	0.1406***	0.0343	1.350	588
FDI	0.112	0.071	57	1.474
Outsourcing	0.0508	0.032	324	1.655

Nearest neighbour matching (n=1), with replacement, caliper (0.01), and kernel.

A5: Heckman correction.

In this section we deal with the "selection bias due to unobservables" deriving from firms' differences that affect the decision to undertake internationalization strategies but that are unobservable and thus uncontrolled that could introduce additional bias in our empirical model. In our study, we deal with this selection problem using the method proposed by Heckman (1974, 1978, 1979) that is a seminal contribution in modeling sample selection.

As said before, Heckman (1979) focused on two types of selection bias: self-selection bias and selection bias made by data analyst. Since he argues that in observational studies, the selectivity is inevitable and the parameter estimated through an OLS could be biased, he proposed a

different approach for settings in which the treatment choice are binary, and the program outcomes depend on a linear combination of observable and unobservable factors.

The basic idea of his approach is to estimate two different equations: in the first one (*the selection equation*) that considers the choice model and a second one (*the regression equation*) that considers the mechanism determining the outcome variable. But it requires an exclusion restriction assumption: the selection equation should include at least one variable to be correlated with the probability that the outcome is observed (in our case, to introduce innovation) but since it is not included in the regression equation, the impact of the this variable on the outcome is indirect, through the selection equation (Costa et al., 2016).

We use a dummy variable identifying if the firm has innovated before (in order to capture a sort of persistency in the innovation process) since a firm that has previously innovated is more likely to introduce innovation in the period before and a lagged dummy variable identifying if the firm is involved in any type of internationalization in order to capture a sort of self selection effects.

In our case, we estimate a probit equation as selection equation to control the selection process and, since the our outcome is a binary variable, we use also a probit equation as outcome equation.

The results shown in Table A13 confirm what we found previously with Probit estimation if we consider any type of innovation. In Table A14, instead, we focus just on

product innovation and also in this Heckman case, the FDI looses significance and exporters are more likely to introduce product innovation. In table A15, instead, we focus on process innovation and all the strategies considered have a positive impact.

Table A13 - Heckman for any type of innovation

	(1)	P.P.(1)	(2)	P.P.(2)	(3)	P.P.(3)
Export	0.264***	0.087				
	(0.073)					
FDI			0.461**	0.154		
			(0.216)			
Outsourcing					0.293***	0.097
					(0.088)	
lage	0.0455	0.015	0.021	0.007	0.0026	0.008
	(0.07)		(0.077)		(0.077)	
_isgruppo	0.0636	0.0211	0.032	0.011	0.039	0.0131
	(0.082)		(0.082)		(0.081)	
_capintensity	-0.0033***	-0.00109	-0.0032***	-0.0011	-0.003***	-0.001
	(0.0006)		(0.0007)		(0.0007)	
_VAempl	2.59e-06	8.6e-07	2.92e-06*	9.73e-07	2.69e-06*	8.97e-07
	(1.60e-06)		(1.59e-06)		1.59e-06	
_hares	0.713***	0.237	0.752***	0.250	0.713***	0.237
	(0.067)		(0.066)		(0.067)	
_sogestr_ctrl	-0.072	-0.024	-0.066	-0.0219	-0.072	-0.0238
	(0.143)		(0.144)		(0.143)	
_patents	-0.101	-0.033	-0.097	-0.032	-0.153	-0.05
	(0.218)		(0.22)		(0.219)	
dimension (n. of employees)						
20-49	0.171**	0.059	0.188**	0.065	0.185**	0.065
	(0.078)		(0.078)		(0.0786)	
50-249	0.434***	0.15	0.468***	0.163	0.469***	0.163
	(0.087)		(0.087)		(0.087)	
>=250	0.678***	0.231	0.71***	0.243	0.716***	0.245
	(0.137)		(0.137)		(0.137)	
Industry	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)
Region	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)
cons	-5,98		-6,230		-5,950	
No. firms	1.969		1.972		1.974	

Standard errors in brackets; * p<0.1; ** p<0.05; *** p<0.01.
Source: own calculation. Industry and region dummies included. In columns (1), (2), and (3), the coefficients are displayed. Predicted Probabilities in column P.P.

Table A14 - Heckman for product innovation

	(1)	P.P.(1)	(2)	P.P.(2)	(3)	P.P.(3)
Export	0.304*** (0.073)	0.105				
FDI			0.198 (0.187)	0.068		
Outsourcing					0.198** (0.084)	0.068
lage	0.0199 (0.076)	0.006	0.004 (0.075)	0.0013	0.003 (0.075)	0.001
_isgruppo	0.0433 (0.08)	0.0014	0.0157 (0.079)	0.0054	0.0178 (0.079)	0.006
_capintensity	-0.0016*** (0.0006)	-0.0006	-0.0016*** (0.0006)	-0.00056	-0.0016*** (0.0006)	-0.0005
_VAempl	2.67e-06* (1.56e-06)	9.15e-07	2.77e-06* (1.54e-06)	9.54e-06	2.76e-06** (1.55e-06)	9.48e-06
_hares	0.626*** (0.066)	0.214	0.667*** (0.065)	0.229	0.64*** (0.066)	0.22
_sogestr_ctrl	-0.037 (0.139)	-0.013	-0.037 (0.138)	-0.012	-0.032 (0.138)	-0.011
_patents	0.0093 (0.209)	0.003	0.02 (0.209)	0.007	-0.023 (0.21)	-0.008
dimension (n. of employees)						
20-49	0.106 (0.079)	0.037	0.122 (0.078)	0.043	0.126 (0.078)	0.044
50-249	0.201** (0.087)	0.07	0.238*** (0.086)	0.083	0.244*** (0.086)	0.0855
>=250	0.435*** (0.132)	0.152	0.485*** (0.131)	0.171	0.489*** (0.131)	0.172
Industry	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)
Region	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)
cons	-5,43		-5,364		-5,350	
No. firms	1.969		1.972		1.976	

Standard errors in brackets; * p<0.1; ** p<0.05; *** p<0.01.
Source: own calculation. Industry and region dummies included. In columns (1), (2), and (3), the coefficients are displayed. Predicted Probabilities in column P.P.

Table A15 - Heckman for process innovation

	(1)	P.P.(1)	(2)	P.P.(2)	(3)	P.P.(3)
Export	0.266	0,039				
	(0.239)					
FDI			0.478	0,070		
			(0.564)			
Outsourc.					0.269**	0.068
					(0.084)	
lage	0.555**	0,081	0.413**	0,061	0.003	0.001
	(0.215)		(0.207)		(0.075)	
_isgruppo	-0.018	-0,003	-0.061	-0,009	0.0178	0.006
	(0.233)		(0.232)		(0.079)	
_capinten	-	-0,383	-	-0.367	-0.0016***	-0.0005
sity	2.622***		2.499***		(0.0006)	
	(0.924)		(0.910)			
_VAempl	0.000	3.66e-07	0.000	4.71e-07	2.76e-06**	9.48e-06
	(0.000)		(0.000)		(1.55e-06)	
_hares	0.360*	0,056	0.419** (	0,062	0.64***	0.22
	(0.193)		0.190)		(0.066)	
sogestr	0.073	0,011	0.022	0,003	-0.032	-0.011
ctrl	(0.433)		(0.442)		(0.138)	
_patents	-0.269	-0,039	-0.269	-0,039	-0.023	-0.008
	(0.603)		(0.610)		(0.21)	
dimensio n (n. of employee s)						
20-49	0.073	0,011	0.142	0,021	0.126	0.044
	(0.269)		(0.268)		(0.078)	
50-249	0.258	0,039	0.318	0,048	0.244***	0.0855
	(0.267)		(0.263)		(0.086)	
>=250	0.644*	0,094	0.773**	0,113	0.489***	0.172
	(0.335)		(0.334)		(0.131)	
Industry	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)
Region	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)
cons	-1,108*		-5,364		-5,350	
No. firms	1.969		1.972		1.976	

Standard errors in brackets; * p<0.1; ** p<0.05; *** p<0.01.
Source: own calculation. Industry and region dummies included. In columns (1), (2), and (3), the coefficients are displayed. Predicted Probabilities in column P.P.

A6: PSM for different destinations.

Table A16 - Strategies/Destinations (PSM caliper KERNEL) – any innovation

		EU 15		
Internationalization strategy	**ATT**	**SE**	**Number of treated**	**Number of controls**
Export	0.084	0.1036	760	41
FDI	0.1215	0.105	21	1055
Outsourcing	0.055	0.0353	214	1736
		NON EU INDUSTRIALIZED		
	ATT	**SE**	**Number of treated**	**Number of controls**
Export	0.0755***	0.0278	920	1067
FDI	0.195***	0.0723	29	1224
Outsourcing	0.1002***	0.0378	160	1752
		NON EU NON INDUSTRIALIZED		
	ATT	**SE**	**Number of treated**	**Number of controls**
Export	0.1439***	0.055	597	309
FDI	0.0838	0.1225	16	897
Outsourcing	0.0436	0.0697	47	1616

Nearest neighbour matching (n=1), with replacement, caliper (0.01) and kernel.
* p<0.1; ** p<0.05; *** p<0.01.

Table A17 - Strategies/Destinations (PSM caliper KERNEL) product innovation

		EU 15		
Internationalization strategy	**ATT**	**SE**	**Number of treated**	**Number of controls**
Export	0.0744	0.108	760	41
FDI	0.0174	0.1175	21	1055
Outsourcing	0.0407	0.037	214	1736
		NON EU INDUSTRIALIZED		
	ATT	**SE**	**Number of treated**	**Number of controls**
Export	0.0755***	0.0277	920	1067
FDI	0.121	0.0901	29	1224
Outsourcing	0.0657	0.0414	160	1752
		NON EU NON INDUSTRIALIZED		
	ATT	**SE**	**Number of treated**	**Number of controls**
Export	0.1215**	0.0582	597	309
FDI	0.1144	0.1296	16	897
Outsourcing	-0.0333	0.0754	47	1616

Nearest neighbour matching (n=1), with replacement, caliper (0.01) and kernel.
* p<0.1; ** p<0.05; *** p<0.01.

Table A19 - Strategies/Destinations (PSM caliper KERNEL) process innovation

		EU 15		
International ization strategy	**ATT**	**SE**	**Number of treated**	**Number of controls**
Export	0.0393	0.1107	760	41
FDI	0.1086	0.1063	21	1055
Outsourcing	0.0049	0.0323	214	1736
		NON EU INDUSTRIALIZED		
	ATT	**SE**	**Number of treated**	**Number of controls**
Export	-0.0129	0.0207	920	1067
FDI	0.0625	0.0905	29	1224
Outsourcing	0.0324	0.0383	160	1752
		NON EU NON INDUSTRIALIZED		
	ATT	**SE**	**Number of treated**	**Number of controls**
Export	0.0051	0.057	597	309
FDI	0.1511	0.1329	16	897
Outsourcing	0.0953	0.071	47	1616

Nearest neighbour matching (n=1), with replacement, caliper (0.01) and kernel.
* p<0.1; ** p<0.05; *** p<0.01.

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DOES PERSISTENCE IN INTERNATIONALIZATION AND INNOVATION INFLUENCE FIRMS' PERFORMANCE?

Chapter 3

1. Introduction.

The ability of a firm to participate in export markets or to invest in innovation is often considered as a key element for competitiveness and as an indicator of success.

The nature of both investment decisions in innovation and in internationalization is, in fact, very strategic but it could be, at the same time, insidious. If it is true, indeed, that both decisions are undertaken according to their own expected returns, they entail some downsides because they are usually risky and costly. In particular, small-medium enterprises (SMEs) could face more problems than their bigger counterparts since SMEs have to face stronger financial constraints to invest in both activities and their decision could be more affected by risk and uncertainty (Esteve-Pérez and Rodríguez, 2013). In addition, as pointed out by some authors (Cohen and Klepper, 1996), larger firms can split the costs associated with innovation and internationalization strategies over a larger output level.

Furthermore, in the analysis of the relationship between innovation and internationalization, it is worth studying two different aspects: how the temporal dimension of firms'

exporting and innovating activities may influence performance and what kind of interrelation (if any) links these two dimensions.

Some recent literature, indeed, underlines that the firms need engagement in innovation to make sure that can take full advantage of foreign knowledge spillovers, because it has been provided evidence that foreign knowledge can improve the performance of already innovative firms increasing their absorptive capacity (e.g. Feldman and Koegler, 2010; Aw et al., 2007).

Some other authors argue that the temporal dimension of firms' exporting and innovating activities may influence the scope of the learning effects as well because the process of knowledge accumulation increases over time as experience is accumulated (Andersson and Lööf, 2009). By persistently performing an activity over time (e.g. R&D investments), accumulating skills and knowledge on how to organize such activity in an always more efficient way, firms can develop new technologies and routines for production to progressively better adapt to the external business environment (Nelson and Winter, 1982).

One of the basic datum of the learning-to-innovate-by-exporting theory (LIBE) assumption is that exports may influence a firm's return in terms of innovation; but the persistency of a firm's export activity may also be important for these returns to materialize and to become important: knowledge flows, indeed, arise from long-lasting and not occasional interactions with foreign customers and competitors as well as the adaptation of better business processes is a consequence for firms exporting regularly.

The reasons why firms decide to continue exporting over time or why they choose between exporting or innovating can be

different, as we will see in the next paragraph, and they have been formalized by the economic literature in different ways.
So the interdependence between innovation and internationalization could be a possible explanation for some post-entry effects on productivity to appear, if we consider that time lags could be important for experience accumulation.
In the previous chapter we have highlighted that there is a learning-to-innovate-by-exporting effect for Italian firms and this is also confirmed if we consider some destinations of export.
What we want to analyze in this chapter is a different aspect of the relationship between innovation and internationalization: how the persistence in innovation activity influences the performance of the firm (measured through the total factor productivity) and if this relationship is different for firms that export persistently or not.
To our purpose, as the panel structure of our dataset and the information provided allow to implement a study that accounts both for persistence and for firms' heterogeneity, we will distinguish firms between persistent and temporary exporters as well as frequent and temporary innovators. It is important to consider that innovation and internationalization can be interrelated and productivity-enhancing learning effects activity over time can be linked to the temporal dimension (thus the persistence) of the firms' activities.
So, moving from an initial unbalanced dataset, we build a balanced one with all the firms observed in all the three waves we consider, on which we test

Table 1 - Matrix of strategies

		Export strategies	
		Persistent	**Non persistent**
Innovation strategies		Persistent Innovators	Persistent Innovators
		Start Innovators	Start Innovators
		Stop Innovators	Stop Innovators

our assumptions to have a first glance of the effect of different innovation strategies, without considering the exports.
From this intermediate step, we will distinguish firms between persistent and temporary exporters , building two different dataset in which we will measure the effect of different strategies both in innovation and in export, to test (through OLS and a two-step system GMM à la Arellano and Bond) the existence of any learning-by-exporting and learning-by-doing effect.
The focus of our analysis is on the importance of the joint effect of persistency in both innovation and export. In particular, we want to see if being permanently active on international markets, associated with being persistently innovators, increases firms' absorptive capacity enhancing their ability of optimizing external knowledge flows.

2. Literature review.

The analysis of the persistency in technological innovation and export, and the interrelation between these two dimensions is fundamental to understand the underlying mechanism of both

industry dynamics and how to implement incisive policies to sustain growth at the firm, sector, and country levels.
In this section, we will go through the most common frameworks that have tried to explain the motivations behind persistence and the interrelation that could arise between innovation and internationalization.

2.1 Why and How do firms decide to persist?

As said in the previous paragraph, the motivations behind the decision of undertaking these strategies, singularly or both, can be several as well as different are the reasons of implementing them persistently or temporarily which have been analyzed and formalized by the economic literature over time.
Nevertheless, we don't have clear and univocal evidence (theoretical and empirical) on how firms have to choose their strategies to perform better.
Some recent studies, for example, provide evidence that the costs of undertaking innovative activities are larger than the costs of exporting (Aw et al. 2007) which explains why innovation is undertaken by fewer firms than exporting, but other authors (Grossman and Helpman, 1991; Aw et al., 2011) have provided theoretical foundation for the interdependence of internationalization and innovation decision at the firm level.
The starting point can be to consider that different strategies can reward firms differently in terms of productivity and, in most of the cases, average outcomes are higher for firms that implement a strategy continuously than for firms that interrupt

them, even if we consider the exporting strategy (e.g. Aw et al., 1998[27]) or the innovation strategy.

However, the persistence of both strategies can be due to different reasons: getting involved in both of them is usually due to investment decisions that firms make according to their own expected return (profits) but there can be some motivations occurring that are not always related to gains in performance.

A firm, indeed, has to face some sunk cost of entry in each activity and uncertainty about its payoff: if we consider the exporting strategy, for example, the existence of sunk costs necessary to enter foreign markets may induce firms to stay into the foreign market, even at the cost of reducing profit margins. Then, exporting experience increases substantially the probability of exporting next year (Roberts and Tybout 1997; Basile 2001). So the decision to export turns out to be a dynamic decision that creates inter-temporal linkages (Esteve-Pérez and Rodríguez, 2013).

The same can be said if we consider the comprehensive level of persistency in innovation, and the availability of firm-level micro data on innovation activity has increased the possibility to explore sources and effects of innovation persistence. [28]

[27] The authors, by comparing productivity of a group of firms which have undergone different patterns of exporting strategies, identify 4 different status for their sample firms: stay out (*firms which do not export neither in period t, nor in period t + 1*), entry (f*irms which do not export in period t and export in period t + 1*), exit (f*irms which export in time t and do not export in time t + 1*), stay in (*firms which export both in t and t + 1*).

[28] From a theoretical point of view, the seminal work of this branch of research is the one by Arrow (1962) in which the author showed that if we compare a monopolistic setting with a competitive market, in the former case a monopolist would have a lower incentives to invest in innovation because it would have less output units to spread the fixed

Many scholars have contributed to understanding the existence of persistence in innovation by applying an incentive-based approach to different research frameworks that can be summarized in three main crucial settings: the "knowledge accumulation" approach, the "success-breeds-success" hypothesis and the concept of sunk costs in R&D activities.

The "knowledge accumulation" hypothesis (or "the competence based-perspective") implies that, due to the intrinsic features of firms' knowledge base, firms build experience in innovation on previous innovation, and simultaneously laying foundations for future knowledge. So, starting from the two main characteristics of knowledge, cumulativeness and the non-exhaustibility, firms are more likely to be successful in future innovation because of learning-by doing or learning to learning effects (Nelson and Winter, 1982;

costs of innovation, and so she prefers to maximize profit by raising price and reducing quantity supplied compared with competitive markets.

According to this approach known as "replacement effect", indeed, the patentee's licensing in a perfect competition market could earn more profit than in a monopolistic market, and R&D activities would not decrease, since a firm in such a kind of market would have high output levels which it can spread fixed costs over and so it would be more inclined to undertake this activities bearing related costs.

Gilbert and Newberry (1982), instead, analyzed a different case: "the business stealing effect". They demonstrated that the choose about innovating or not is not a prerogative only of the potential entrants, but if the monopolist perceive the threat of the potential entrance of a competitor adopting an innovation, the incumbent has to face the decision to undertake innovation or to allow the rival to have it, facing the consequences of a possible competitive disadvantage. In this kind of setting, the incentives for the potential entrants could be lower than the monopolist's incentives, if only to deter possible successful rivals' entry (*"The monopolist will preempt if the cost is less than the profits gained by preventing entry"*).

Duguet and Monjon 2004; Latham and Le Bas 2006; Antonelli, Crespi, and Scellato, 2012). This process, most of the times, is set up by introducing a starting radical innovation followed by series of incremental improvements increasing the forswear of the primal innovation (Rosenberg, 1982) and through this process of progressive experience and learning ability accumulation, the firms can be more successful for future innovation (Weitzman, 1996).

Nevertheless, as said before, funding the innovation activities is a serious problem that firms frequently face because of financial constraints and also because innovation are capital-intensive, risky, and with a long-term payoff. Gaining market power and recording previous successful innovation can provide firms with internal funding raising the possibility of iterating innovation activities because of a long-lasting effect on profitability of past innovation (Antonelli, Crespi, and Scellato, 2012) .

Moving from this point, the second hypothesis ("success-breeds-success hypothesis" or "resource constraints perspective") gives a crucial role to the economic and commercial success. This approach, indeed, asserts that innovation can lead to profitability, which later funds innovation activities triggering off an iterative process of innovation (Flaig and Stadler, 1994; Latham and Le Bas, 2006). Innovating firms, therefore, can gain profits above the market average persistently and so with resulting internal cash flows, they can spend in innovation facing easier costs and reducing financial constraints to innovate persistently in the following years (Cefis and Ciccarelli, 2005; Hall, 2002; Brown et al. 2009).

The third theoretical perspective on the innovation persistence moves from one of the main limits of the "replacement effect" framework: to not consider the existence of start-up costs associated with undertaking R&D activities (among others:

setting up an R&D laboratory; hiring and training specialized employees; collecting market information). Once invested in R&D activities, those entailed costs are sunk and this kind of activities implies also a long-term commitment. According to some authors *(*e.g. Antonelli, Crespi, and Scellato, 2012), these features can be barriers to entry, stay and exit from a specific regime of innovation configuring a sort of state-dependence (or inter-temporal stability) in innovation efforts. For previous non-innovators, indeed, the costs increase the risk of R&D and deter entry into innovation activities. For innovators, they reduce costs of future innovation activities and therefore make their pursuit more attractive (e.g., Máñez et al., 2009).

However, the different frameworks analyzed are more complementary than in competition and there is no uniform evidence or discriminatory testing that could give us a comparable measure of validity (Le Bas and Scellato, 2014).

The results are not consistent and they can vary according to the innovation indicator adopted: on one hand the persistence is weak if the indicator used is patenting, but using such indicator has been largely criticized for providing an incomplete information (Antonelli, Crespi, and Scellato, 2012, Clausen et al., 2013); on the other hand, if the indicator is drawn by a survey, the effect of innovation persistence is consistently stronger, particularly for the product innovation.

Furthermore, innovation persistence differs significantly across sectors, firms size classes, or if we consider different types of innovation: firms implementing mixed strategies of innovation (product *and* process) turn out to be more persistent than single innovators (product *or* process innovation).

The hypothesis above cited can also be self-reinforcing since they can interact in some way giving rise to a virtuous circle: for example, both the "knowledge accumulation" and the "success-

breeds-success" hypotheses can create a scenario in which profits generated by the economic success fund R&D activities that can give the floor to the learning process to continue (Latham and Le Bas, 2006; Le Bas and Scellato, 2014).

It is worth to note, in conclusion, that the frameworks we have analyzed with respect to innovation persistence, can be extended to the export strategy. For example, the knowledge based dimension of exports is given by the regular interaction with foreign consumers, or the experience accumulated that increase returns to scale of production. But the decisions of investing in innovation or of starting to export are interrelated and can be conditioned one by the other (e.g. Ito and Lechevalier, 2010): expected returns form export participation are higher for those firms that have accumulated internal knowledge through innovation and R&D investments but previous exporting experience generates knowledge flows that enhance the innovative capability of firms.

2.2 Innovation and Internationalization: a Two-Way Relationship and the Role of Productivity.

An important aspect can be the interrelationship between exports and innovation and the existence of any possible pathways linking them since most of the empirical studies using firm-level data has frequently overlooked the relationship between export and R&D activities focusing on either innovation or export engagement, whilst considering the other activity as one of its determinants.

As it has been recently pointed out by Aw et al. (2008, 2011), export and technology decisions are interdependent and both can influence a firms' future profitability explaining why exporters usually show better performances than non-exporters. In their structural model, they have started from the assumption that technology investments and export are undertaken depending on their expected returns but they are interrelated since, on one side, technology investments may spur firms' productivity raising expected (net) profits from exporting, and, on the other side, trade with foreign countries could increase the return to the firms' technology investment.

Apart from that, this kind of framework can lead to persistence in each activity a we have already discussed. Another important issue of this work is that they highlight two important features: the existence of a two-way relationship between engagement in export and R&D activities (that is, past participation in export (innovation) raises the expected return from innovation (exporting), propelling current participation) and the crucial role played by productivity. Both innovation and export decisions increase future productivity but they are based on past levels of productivity itself and so the net benefits of any strategy vary according to changes in productivity levels.

The importance of the productivity in dynamic models of export participation is highlighted by different authors (Melitz, 2003; Bernard and Jensen, 2004) arguing that firms draw their productivity level from a known statistical distribution (the productivity are not derived endogenously in these models) and more productive firms start export while less productive do not export or leave the market. These ex-ante productivity differences between exporters and non-exporters can be explained by previous involvement in technological activities

since they can be useful to build an absorptive structure for external knowledge.

Empirically, there is a growing number of studies that examine this relationship finding that different strategies reflect differences in productivity. (e.g. Cassiman and Martínez-Ros, 2007; Damijan et al, 2010, 2015; Becker and Egger, 2013).

More recently, Lööf et al. (2015) found that persistently innovating and persistently exporting firms grow (in terms of productivity) faster than persistently exporters that switch from being innovator to not. They distinguished different strategies of internationalization and innovation, finding that a persistent engagement in innovation investments enhances the capacity of the firms to absorb the knowledge they acquire from international activities. This absorptive capacity is influenced also by the local and regional environment: the more knowledge-intensive the social milieu, the more the firms benefit from exporting.

Some other papers, instead, try to explain how mixed strategies may enhance firms' productivity. A more recent study by Damijan et al. (2015), instead, by exploring the learning effects of firms' participation in both importing and exporting through innovations, finds that both may have important beneficial effects on firm performance. The authors argue that *"a firm may learn through its international contacts and demand-supply linkages, which may, in turn, be reflected in its innovation efforts, in terms of new products or new processes"*. This learning process, however, does not translate immediately into productivity boosts, and could have an impact on productivity growth only in the long run. They highlight that there may be an exact sequence of firm's participation in trade and subsequent learning effects, starting either by trading status (importing/exporting) or by innovator

status (product, process or joint product-process). The results indicate that smaller firms benefit from import links to learn production process, and this may help them to get prepared for entering to foreign markets.
In conclusion, the study of the interrelationship between all the different strategies (in terms of both trade participation and innovation) is still characterized by heterogeneity and it needs further research to accumulate a body of empirical evidence to serve as basis for an unquestioning acceptance of the phenomenon.

3. Data and descriptive statistics.

In this chapter we will use the data from Capitalia, now taking up a different design with respect to the previous chapter.
As said previously, our main purpose of analysis is to go into a different aspect of the relationship between innovation and exports: we want to see if the persistence in both of them influences the firms performance in terms of productivity.
The panel structure of our dataset and the information provided allow to implement a study that accounts for persistence, so starting from the initial unbalanced dataset, we build a balanced one with all the firms observed in all the three waves we consider. Moving from this intermediate step, we will distinguish firms between persistent and temporary exporters[29],

[29] In this chapter we do not distinguish between different internationalization strategies as in previous chapter. This would be interesting but the structure and the number of observation at our disposal do not allow to identify persistency in other international activities (e.g. FDI and outsourcing).

building two different dataset in which we will measure the joint impact of different strategies (already summarized in the Table 1) on the categories of firms. We considered three different strategies of innovation activity: first of all, we identify as a *persistent innovator* a firm which persistently innovate over the time span we consider; second, a *start innovating firm* is a firm that has not innovated at time *t-1* and starts innovating a *t*; finally, we identify the *stop innovating* firms as those innovating at *t-1* but that do not show any innovation at time *t*.

The starting dataset is a dataset with 14.106 observations (more than 4.700 observations, on average, per wave) covering an eight-year period (1998-2006); it is unbalanced and it contains observations on more than 10.700 firms. As already said, we combined the data obtained by merging the three different waves, initially separated, by using an identifying number for each firm, that allowed us to add also balance sheet information to our dataset.[30]

As we can see from Table 2, in the sub-datasets of the balanced panel we have isolated the persistent exporters, that representing the majority of the firms (62,53%) of the starting balanced panel, whilst the remaining (37,47%) has not exported permanently.

[30] As in the previous chapter, also in this case, balance sheet data are gathered from CERVED dataset. Moreover, firms included into the surveys are in part renewed at a three-years time interval, given the particular design of the panel (stratified and rotating). This kind of approach is carried out for two different motivations: on one hand, to analyze variations of firms observed, for the part of the survey that is kept constant; on the other hand, to analyze any structural change of the Italian economy, for the part of the sample varying in each wave.

Table 2 - Comparing the datasets

DATASET	Balanced Panel	Persistent Exporters	Non Persistent Exporters
Observations	1.353 *(100%)*	846 *(62, 53%)*	507 *(37,47%)*
Unique firms	451	282	169

Source: own calculation.

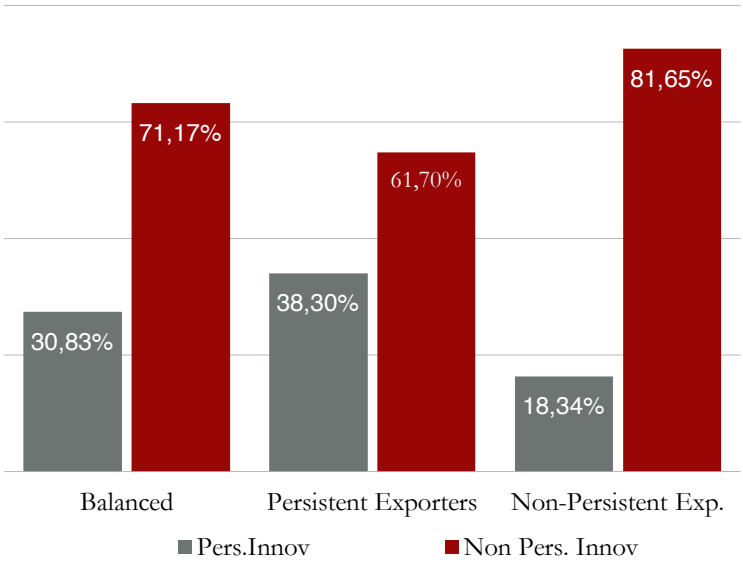
Looking at innovation, instead, firms that innovate persistently is, as expectable, the minority compared to persistent innovators. Results from Table 3 suggest that exporting over time is somehow associated more frequently with innovation since the percentage of persistent innovators grows in this case, whilst the non persistent innovators' percentage is higher in the case of non persistent exporters.

Table 3 - Comparing the datasets - Persistent innovators

DATASET	Balanced Panel		Persistent Exporters		Non Persistent Exporters	
	Pers. Inn.	Non-Pers. Inn	Pers. Inn.	Non-Pers. Inn	Pers. Inn.	Non-Pers. Inn
Observations	417	936	324	522	93	414
Unique firms	139	312	108	174	31	138

Source: own calculation.

Figure 1



If we compare the two groups through summary statistics[31] (Table 4), we can see that if we do not make any distinction about the innovation strategy, on average, persistent exporters are slightly more mature but significantly larger than their counterparts and they are also more capital intensive and productive.

[31] In this table, the first four rows are computed as in the Table 4 of Chapter 2 to ensure the comparison of these characteristics between the datasets used. These features are in keeping with those of the firms present in the unbalanced panel.

Table 4 - Summary statistics: Persistent vs. Non-Persistent exporters (1998-2006)

	Persistent Exporters			
	Mean	**Std. Dev.**	**Min**	**Max**
Average age (in years)	33,638	19,11	0	242
Average Number of Employees	225,8	710,81	7	9097
Average capital intensity (in thousands of €)	145,73	460,37	0	8171,4
Average productivity (Value added per employee)	64.335,58	204.625	339,06	532.6621
	Non-Persistent Exporters			
	Mean	**Std. Dev.**	**Min**	**Max**
Average age (in years)	31,899	20,769	0	175
Average Number of Employees	113,03	408,45	4	6337
Average capital intensity (in thousands of €)	114,07	317,36	0,002	3.141,3
Average productivity (Value added per employee)	54.568,53	54.183,42	3.294,936	767.304,6

Source: own calculation

It turns out that similar results come up if we compare firms' characteristics without any distinction about exporting

Table 5 - Summary statistics: Persistent vs. Non-Persistent Innovating (1998-2006)

	Persistent Innovating			
	Mean	**Std. Dev.**	**Min**	**Max**
Average age (in years)	33.619	19,445	0	133
Average Number of Employees	212,732	416,386	7	5.128,667
Average capital intensity (in thousands of €)	118,516	271,444	0,002	2764,69
Average productivity (Value added per employee)	77.891,45	289.709,9	5.891,242	5.326.621
	Non-Persistent Innovating			
	Mean	**Std. Dev.**	**Min**	**Max**
Average age (in years)	31,899	20,769	0	175
Average Number of Employees	113,03	408,45	4	6337
Average capital intensity (in thousands of €)	114,07	317,36	0,002	3.141,3
Average productivity (Value added per employee)	54.568,53	54.183,42	3.294,936	767.304,6

Source: own calculation

strategies [32] . Firms that undertake permanently innovation strategies seems to be more mature and bigger besides being more capital intensive and productive (Table 5).

Now we investigate the characteristics of the firms crossing the strategies, through the (unconditional) distribution (on a log-scale) of the total factor productivity[33] (Figure 2), of the age (Figure 3), and of the size (Figure 4). There are several ways to estimate distributions following both parametric and non-parametric frameworks, with different advantages and disadvantages. We decide to use a non-parametric approach because ,unlike the parametric one (that focuses typically on two different moments of the distribution: the conditional mean and the variance), it allows to see the evolution of the entire distribution of the variable over time distribution. Moreover, the non-parametric approach is much more suitable when the object of analysis are large and heterogeneous samples of firms (Iona et al., 2013).

There are several alternative kernel functions that can be used according to different purposes. We use the Gaussian kernel[34] because of its property of monotonicity that turns out to be useful when comparing distributions over time is of interest (Silverman, 1986). The bandwidth is set according to the "optimal" rule from Silverman (1986) that works well when the Gaussian kernel density function is applied (Iona et al., 2013).

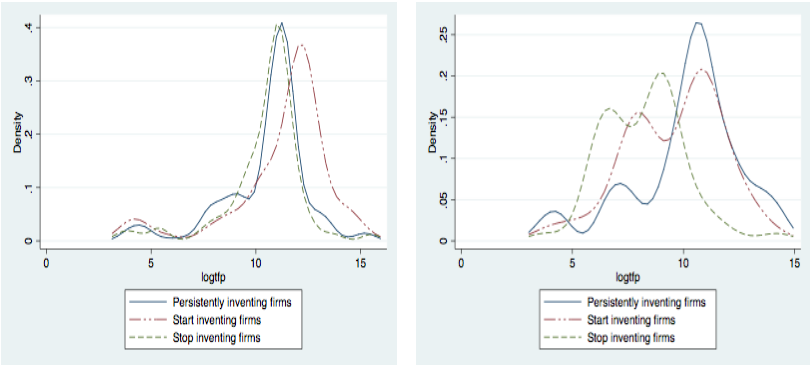
[32] These summary statistics are computed on the Balanced Panel.

[33] In this case, as in our estimations, the TFP is calculated à la Levinsohn-Petrin, as we will see in the next paragraph.

[34] We also estimated densities with the Epanenchnikov kernel function, setting the bandwidth according to the "optimal" rule from Silverman (1986), and the results were very similar. See appendix

We report the kernel density to compare, among the two groups of persistent and non-persistent exporters, these characteristics of persistent innovators and firms that start or stop innovating.

Figure 2 - Kernel densities of total factor productivity (TFP) for persistent exporters (left) and non-persistent exporters (right), by different innovation strategies.



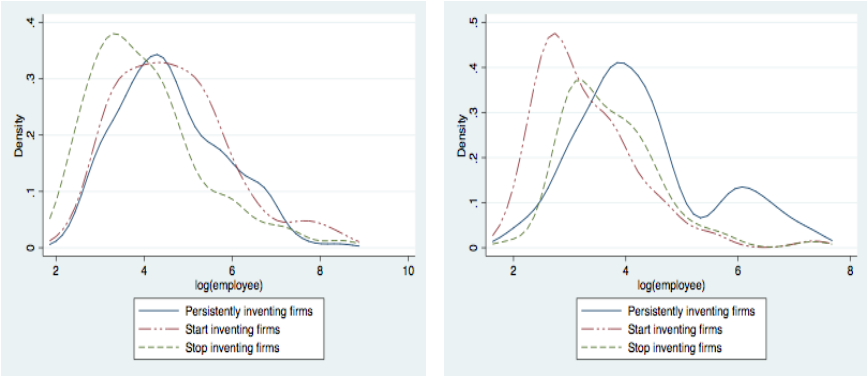
At a first glance, if we look at Figure 2, we can see that in the case of persistent exporters (left), the densities tend to display a tent-shape and fatter tails especially in the case of start-inventing firms. This kind of evidence is in support of the application of regression techniques that can account for the heterogeneous role of innovation strategies.

It is worth, also, to highlight that kernel estimates show some kind of different results for different strategies of innovation and, in particular, in both groups, persistent innovators show less dispersed TFP values.

Looking at the distribution of the densities, if we consider firms' size (Figure 3) they are left-shifted, confirming that the Italian entrepreneurial scenario is built on SME, and also in this case, a

greater "uniformity" is displayed in the case of persistent exporters (left) than non persistent exporters (right).

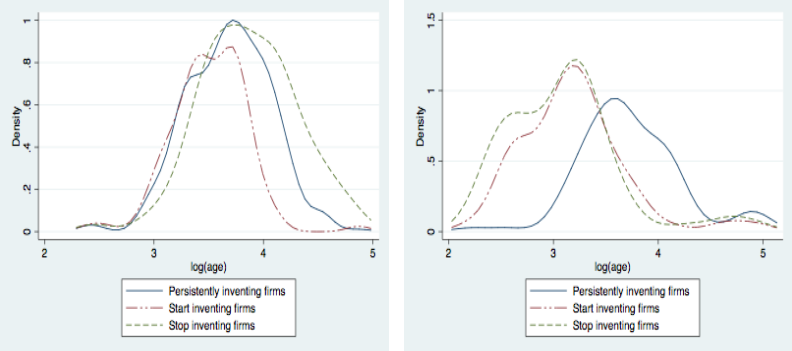
Figure 3 - Kernel densities of average number of employees (in log) for persistent exporters (left) and non-persistent exporters (right), by different innovation strategies.



Finally, comparing the densities by firms' age (Figure 4), here the densities are right-shifted and in the case of persistent innovators (in the non persistent exporting group) this difference is more apparent.

In conclusion, the persistent innovators appear, in distributional terms and from the very preliminary summary statistics computed, more productive, larger and older and this is both if they are persistent exporters or not.

Figure 4 - Kernel densities of age (in log) for persistent exporters (left) and non-persistent exporters (right), by different innovation strategies.



4. Empirical specifications and estimation strategy: From Innovation to TFP.

In this session we deepen the analysis of the role of innovation in enhancing firms' productivity to examine, by econometric tools, whether differences in learning-by-exporting can be explained by differences in persistence of firms' innovation activities.

So, first, we exploit the classification of firms into persistent exporters vs. non-persistent exporters and, second, we measure the effect of different strategies of innovation on productivity over the available time-span (1998-2006).

Our approach is based, first of all, on the estimation of the productivity that will be our variable of interest. Specifically, we

measure the total factor productivity at sector level (henceforth, TFP) à la Levinsohn and Petrin (2003)[35].

Moreover, we use a dummy variables as proxy of innovation, identifying the innovation strategies. Despite the existence of a considerable stream of literature that uses other indicators of innovation (e.g. patents), there has been a discussion about the advantages and disadvantages of using patents (e.g. Grilliches, 1990; Lööf , 2015): even if patents can be more objective, the innovation does not always lead to patent applications.

Then, to explore at which extent the learning by exporting effect varies across different types of firms, we next take into account the heterogeneity that characterizes firms in our dataset. We focus on three dimensions of heterogeneity that affect the knowledge acquisition process: the ownership; if firms have undertaken any foreign direct investment; the investments in innovation.

Concerning the ownership, we control for foreign ownership through a dummy variable that indicates if the controlling stake of the firm is owned by a foreign agent. Moreover, we next consider if the firm is part of a group and if the firm has invested abroad through FDI through two different dummy variables.

For the investment in innovation, we use two dummy variables indicating if the firm has invested in ITC or in R&D. Investing in this kind of activities, indeed, enhances the absorptive

[35] Considering that according to the authors the productivity follows a first-order Markov process, we include the lagged *tfp* and a vector of firm characteristics which includes firms' size measured by the logarithm of the average number of employees, the logarithm of total real assets, and the logarithm of the inputs.

capacity of the firm i.e. the ability of internalizing the knowledge flows that come from the contact with foreign consumers.

Table 5 - Summary statistics: Persistent vs. Non-Persistent exporters

	Persistent Exporters					Non-Persistent Exporters				
	Obs.	**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
TFP[a]	734	10,28	1,931	3,086	15,55	439	9,625	2,073	3,531	16,42
Pers. Innov	846	0,383	0,486	0	1	507	0,183	0,387	0	1
Start Innov	846	0,128	0,334	0	1	507	0,148	0,355	0	1
Stop Innov	846	0,102	0,302	0	1	507	0,128	0,335	0	1
Inves. ITC	758	0,840	0,366	0	1	436	0,786	0,410	0	1
Inves. R&D	825	0,659	0,474	0	1	497	0,428	0,495	0	1
FDI	588	0,063	0,243	0	1	336	0,012	0,108	0	1
ForOwn	846	0,072	0,259	0	1	507	0,037	0,19	0	1
Group	841	0,299	0,458	0	1	505	0,194	0,396	0	1
Age	842	33,63	19,11	0	232	507	31,89	20,76	9	165
Size[b]	836	225,8	710,8	6,67	9097	496	113,1	408,4	4	6337

[a] The productivity is computed a la Levinsohn-Petrin.
[b] The size is computed as the average number of employees.
For the sake of brevity, industry and area dummies are not displayed.
Source: own calculation

Finally, we include a set of controls for firms' age, localization, and industry and we control for firms' size using both the number of employees and its square to control for collinearity.
The variables in the two datasets we use are summarized[36] in Table 5.
So, starting from the idea that firms can undertake different strategies both on the innovation side and on the export side, we will proceed by steps: we want to see, separately, the effect on TFP, first of all, of exporting (persistently or not); second, we want to see how the different innovation strategies influence the productivity of the firm, without considering the effect of the export strategy; finally, to consider the effect of both strategies jointly, we will estimate our equation of interest on datasets divided according to the exporting strategy.
We start from the assumption that the firm i desired productivity level at time t, TFP^*_{it} is function of international strategy (I_{it}), a set of firms specific characteristics (F_{it}).

$$TFP^*_{it}=TFP^*(I_{it}\,;F_{it}) \qquad (1)$$

The drawback of our model is that firms are not assumed to change the level of the productivity easily since it would require some structural changes in capital, production process, workforce composition that would require time.
For this reason, our model can be considered as based on a partial adjustment model in which the changes in productivity could take place gradually and the difference in productivity between periods t and $t-1$ is some fraction $0< \lambda \leq 1$ of the TFP

[36] In the Appendix (Table A1), the variables are also displayed for the balanced Panel.

desired level, that captures the delay in the adjustment process (Leonida et al. 2013).

$$(TFP_{it} - TFP_{it-1}) = \lambda \left(TFP^{*}_{it} - TFP_{it-1}\right) \quad (2)$$

then,

$$TFP_{it} = (1-\lambda)\, TFP_{it-1} + \lambda TFP^{*}_{it} \quad (3)$$

So we combine the Equation (1) with Equation (3), considering the international strategy in the variable *Strategy* that can be different according to the strategy chosen, and we add the firms specific characteristics:

$$TFP_{it} = \alpha + \beta_1 TFP_{it-1} + \beta_2\, Strategy_{it} + \beta_3\, Ownership_{it-1} + \beta_4\, ITC_{it-1} + \\ + \beta_5\, R\&D_{it-1} + \beta_6\, FDI_{it-1} + \beta_7\, Group_{it-1} + \beta_8\, Size_{it-1} + \beta_9\, Size^{2}_{it-1} + \beta_{10}\, X_{it} + u_{it} \quad (4)$$

So, we will estimate a specific version of Equation (4):

$$TFP_{it} = \alpha + \beta_1 TFP_{it-1} + \beta_2\, Pers\_Invent_{it} + \beta_3\, Start\_Invent_{it} + \beta_4\, Stop\_Invent_{it} + \beta_5\, Ownership_{it-1} + \\ + \beta_6\, ITC_{it-1} + \beta_7\, R\&D_{it-1} + \beta_8\, FDI_{it-1} + \beta_9\, Group_{it-1} + \beta_{10}\, Size_{it-1} + \beta_{11}\, Size^{2}_{it-1} + \beta_{12}\, X_{it} + u_{it} \quad (5)$$

in which the innovation is considered through different strategies and the export is measured through splitting the dataset in persistent exporters and non-exporters.

The dependent variable is the TFP à la Levinsohn-Petrin, but, since the contemporaneous productivity is closely related to productivity in previous periods, on one hand, it motivates the lagged structure of the model and, on the other hand, it is necessary to model the regression as an autoregressive process in which we will include on the right-hand side the 1-period lagged TFP.

After the dummies for innovation strategies (*Pers_Invent; Start_invent; Stop_Invent),* then we include a set of (lagged) variables to control for firms heterogeneity. In particular, we consider a dummy for the ownership identifying if the firm is foreign-owned or not (*Ownership*); two different dummies for investing both in information, technology and communication (*ITC*) and in research (*R&D*); moreover, we consider two more dummies, one indicating if firms have invested abroad (*FDI*) and if it is in a group of companies (*Group*). To control fo firms size, instead, we use the size of the firms computed as the number of employees and its square. Finally, we include a set of controls for firms' age (in logarithm), localization (North, South, South-East, South-West, and Islands), and industry (ATECO classification - 2 digit).

Firstly, we estimate this equation through a simple OLS regression just to have a simple clue of the existence of any relationship.

In our model, the presence of the lagged dependent variable, TFP_{it-1}, captures the adjustment process of the dependent variable; it is necessarily correlated to the firms specific characteristics even if the idiosyncratic component of the error

term is serially uncorrelated and, so, the OLS estimator leads to inconsistent parameter estimates.
So, we make use of the two step system general methods of moments (GMM) estimator developed by Arellano and Bond (1991) which allows us to control for any possible simultaneity and endogeneity problem in our model and also because our panel present the typical structure "small T , large N ".
This methodology is useful because it makes the additional assumption that the first differences of the instrumenting variables are uncorrelated with the fixed effects (Leonida et al., 2013). The validity of the instruments is tested using the Hansen and Sargan statistics and the Hansen in difference test to test the validity of additional moment conditions.

5. Persistence vs Temporariness.

As said before, first of all we want to see how the different strategies influence firms' productivity, at a first stage separately and then jointly.
At a first stage, we consider the effect of exporting persistently, without making any distinction on the innovation decisions (Table 6). So, we first estimate the equation (1) for the balanced panel without making any distinction about innovation and using a dummy that identifies if the firm has exported permanently (or not) over the time-span considered. We

consider at first an OLS estimation and then the two-step system GMM[37].

The results in Table 6 show that exporting persistently seems to have a positive effect on TFP but it is not significant. If we focus on GMM results, it comes out that, even if all the variables considered show positive coefficients apart from being part of a group, investing abroad, and being more mature firms that export persistently which all have an higher return in terms of productivity.

Making a little step forward, we want to see if there could be an effect for firms that export (now we use a dummy just indicating if the firm exports or not) and innovate persistently. Looking at the results in Table 7, we can see that the strategies considered show not significant coefficient but, in the case of exports, it is also negative. In the GMM column, for firms that export and persistently innovate, only the age seems to have a positive effect on productivity since more mature firms may have acquired knowledge that allows to perform better.

[37] In all estimations, we consider the time invariant variables as instruments treating the time-variant ones as potentially endogenous, generating GMM-style instruments for them. We consider instruments lagged one time. Industry dummies, region dummies and age are always included in the instruments set.

Table 6 - Estimation results (B.P.) - Strategy: Pers. Exp.; Dependent variable: TFP.-1

	OLS	GMM
TFP_{it-1}	0.160***	0.177***
	(0.053)	(0.063)
Pers. $Export_{it}$	0.025	0.026
	(0.045)	(0.062)
ITC_{it-1}	0.034	0.002
	(0.047)	(0.055)
$R\&D_{it-1}$	0.123***	0.036
	(0.046)	(0.044)
FDI_{it-1}	0.127	0.203**
	(0.107)	(0.097)
$ForOwn_{it-1}$	-0.028	-0.044
	(0.099)	(0.090)
$Group_{it-1}$	0.205***	-0.103
	(0.060)	(0.114)
Age_{it-1}	0.046	0.114**
	(0.036)	(0.058)
$Size_{it-1}$	0.001*	0.001
	(0.000)	(0.001)
$Size^2_{it-1}$	-0.000	-0.000
	(0.000)	(0.000)
Industry	(Yes)	(Yes)
Region	(Yes)	(Yes)
cons	8.620***	8.651***
No. obs.	579	331
Sargan test		0.108
Hansen test		0.442
Difference in Hansen		0.249

Balanced Panel. *i* indexes firms and *t* time
* p<0.1; ** p<0.05; *** p<0.01
Standard errors in brackets.
Source: own calculation. Industry and area dummies included

Table 7 - Estimation results (B.P.) - Strategy: Pers. Inn. & Export; Dep. Var.: TFP.

	OLS	GMM
TFP$_{it-1}$	0.159***	0.145**
	(0.053)	(0.060)
Pers. Innov$_{it}$	0.062	0.026
	(0.048)	(0.064)
Export$_{it}$	-0.058	-0.001
	(0.051)	(0.085)
ITC$_{it-1}$	0.037	-0.011
	(0.049)	(0.059)
R&D$_{it-1}$	0.129***	0.081
	(0.047)	(0.050)
FDI$_{it-1}$	0.134	0.065
	(0.107)	(0.094)
ForOwn$_{it-1}$	-0.028	-0.072
	(0.099)	(0.087)
Group$_{it-1}$	0.214***	-0.050
	(0.062)	(0.116)
Age$_{it-1}$	0.049	0.109*
	(0.037)	(0.059)
Size$_{it-1}$	0.001*	0.001
	(0.000)	(0.001)
Size$^2_{it-1}$	-0.000	-0.000
	(0.000)	(0.000)
Industry	(Yes)	(Yes)
Region	(Yes)	(Yes)
cons	8.643***	8.978***
No. obs.	571	324
Sargan test		0.101
Hansen test		0.475
Difference in Hansen		0.293

Balanced Panel. *i* indexes firms and *t* time; * p<0.1; ** p<0.05; *** p<0.01; Standard errors in brackets. Source: own calculation. Industry and area dummies included

In order to understand if the strategy reward firms more if they are undertaken jointly and persistently, it is fundamental to consider also the effect of the different innovation strategies on TFP without considering the export dimension. Now we estimate the Equation (2) first of all on the Balanced Panel (Table 8) and then, as already said, splitting the sample in persistent exporters and non-persistent exporters (Table 9).

If we look at the column of OLS in Table 8, first of all, we can see that all the strategies introducing innovation persistently shows an higher coefficient with respect to other strategies, but only starting innovation shows a significant (although weakly) coefficient. Stop innovating, instead, shows a positive but not significant coefficient.

As expected, investing in ITC and R&D show positive coefficients (the latter also significant) since the involvement in these activities enforces the possibility of accumulating knowledge that can spur productivity.

Concerning the foreign ownership and being part of a group of companies, in the first case, the coefficient is negative and not significant, in the second it is positive and significant. These results suggest that firms could benefit in productivity from knowledge flows that arise from links and connections with other firms.

If we look at the column of GMM estimation, the lagged TFP shows a positive and significant coefficient and the results are pretty similar even though, in this case, the coefficient of innovation strategies loose significance.

Table 8 - Estimation results (B.P.) - Strategy: Pers./Start/Stop Inn. - Dependent variable: TFP

	No distinction between exporting strategies	
	OLS	**GMM**
TFP$_{it-1}$	0.160***	0.157***
	(0.052)	(0.059)
Pers. Innov$_{it}$	0.083	0.088
	(0.068)	(0.058)
Start Innov$_{it}$	0.082*	-0.057
	(0.049)	(0.058)
Stop Innov$_{it}$	0.009	0.009
	(0.044)	(0.054)
ITC$_{it-1}$	0.035	0.031
	(0.048)	(0.050)
R&D$_{it-1}$	0.116**	-0.014
	(0.050)	(0.047)
FDI$_{it-1}$	0.128	0.205**
	(0.107)	(0.093)
ForOwn$_{it-1}$	-0.029	-0.027
	(0.101)	(0.087)
Group$_{it-1}$	0.201***	-0.131
	(0.058)	(0.117)
Age$_{it-1}$	0.051	0.171***
	(0.036)	(0.058)
Size$_{it-1}$	0.001*	0.001
	(0.000)	(0.001)
Size$^2_{it-1}$	-0.000	-0.000
	(0.000)	(0.000)
Industry	(Yes)	(Yes)
Region	(Yes)	(Yes)
cons	8.587***	8.691***
No. obs.	579	331
Sargan test		0,108
Hansen test		0.470
Difference in Hansen		0.366

* p<0.1; ** p<0.05; *** p<0.01; *i* indexes firms and *t* time
Standard errors in brackets.
Source: own calculation. Industry and region dummies included

Table 9 - Estimation results for different exporting strategies - Dependent variable: TFP

	Persistent Exporters		Non Persistent Exporters	
	OLS	**GMM**	**OLS**	**GMM**
TFP$_{it-1}$	0.199**	0.329***	0.188***	0.542***
	(0.097)	(0.115)	(0.061)	(0.156)
Pers. Innov$_{it}$	0.075	0.215**	0.030	-0.201*
	(0.095)	(0.098)	(0.100)	(0.121)
Start Innov$_{it}$	0.068	0.028	0.089*	-0.023
	(0.081)	(0.095)	(0.052)	(0.084)
Stop Innov$_{it}$	0.001	0.135	0.022	-0.177
	(0.069)	(0.086)	(0.055)	(0.116)
ITC$_{it-1}$	0.043	-0.049	-0.029	-0.077
	(0.061)	(0.098)	(0.066)	(0.121)
R&D$_{it-1}$	0.076	0.032	0.144**	0.252*
	(0.068)	(0.094)	(0.066)	(0.145)
FDI$_{it-1}$	0.137	0.310**	-0.023	0.183
	(0.116)	(0.138)	(0.296)	(0.310)
ForOwn$_{it-1}$	-0.008	0.039	-0.051	-0.144
	(0.106)	(0.102)	(0.199)	(0.206)
Group$_{it-1}$	0.271***	-0.124	0.055	-0.031
	(0.083)	(0.160)	(0.082)	(0.302)
Age$_{it-1}$	0.043	0.159*	0.023	-0.300*
	(0.043)	(0.086)	(0.067)	(0.155)
Size$_{it-1}$	0.000	0.001*	0.001*	0.002
	(0.000)	(0.000)	(0.001)	(0.001)
Size$^2_{it-1}$	0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Industry	(Yes)	(Yes)	(Yes)	(Yes)
Region	(Yes)	(Yes)	(Yes)	(Yes)
cons	8.192***	6.770***	8.519***	0.000
No. obs.	360	211	219	218
Sargan test		0.156		0.231
Hansen test		0.888		0.289
Diff. in Hansen		0.644		0.289

* p<0.1; ** p<0.05; *** p<0.01; *i* indexes firms and *t* time
Standard errors in brackets.
Source: own calculation. Industry and area dummies included

Furthermore, investing abroad ensures a positive return in productivity since firms that are involved in this internationalization strategy can acquire competences that, once internalized, can have a positive impact on TFP and, moreover, seems that more mature firms perform better that younger firms.

What we are really interested in is the joint effect of innovation and export persistence and so we will estimate Equation (2) for two alternative panels corresponding to persistent exporters and non-persistent exporters (Table 9).

When the assessment is restricted to different exporting strategies, the lagged TFP is positive and significant (in the GMM as in the OLS estimations) since, as said, the current value of productivity is influenced by previous values.

If we look, instead, at the at the column of GMM estimations, the innovation strategies show different coefficients. What comes out is that innovating persistently has a positive (and significant) effect on productivity, only if it is also associated with a continuous exporting strategy. By contrast, temporary innovation efforts do not show significance and this could be due to the fact that firms that switch from not innovating to innovating or viceversa can not benefit from the process of knowledge accumulation since the internalization of knowledge flows could require time to be turned into productivity gain.

A preliminary and tentative conclusion we can draw is that mature firms starting innovation activity get returns on TFP as well as that being involved in foreign direct investments can facilitate knowledge flows between firms triggering a learning-by-doing effect.

Also in this case, investing abroad has a positive and significant effect on productivity only if it is associated with persistent exports. Investing abroad, indeed, is usually a less preferred

strategy since it is more complex, requiring higher investments and commitment and it usually comes in a second moment with respect to export.
Moreover firms that do not export permanently are more concentrated on internal R&D than their exporting counterparts since exporting in some cases can replace internal R&D.
Finally, if we look at the age of the firms, we can see that older firms that do not export persistently may suffer the competition of younger firms, whilst those that export, even older, may benefit from exporting persistently in terms of productivity by having access to knowledge keeping up with tastes of consumers. In all our estimations, no evidence of serial correlation in the error terms can be found: the null hypothesis that the population moment conditions are correct is not rejected because the p-value for both the Hansen and the Sargan statistics is >0.05. Further, the Hansen in difference test does not reject the validity of the additional moment conditions used by system GMM.

6. Concluding remarks.

In this chapter we have investigated the role of innovation and export in influencing productivity for Italian manufacturing firms for a eight-year time-span. We consider three different strategies in innovation that firms can pursue: firms can persistently innovate iterating their activity all over the period; they can start innovating if in previous period they have not innovated; finally they can stop introducing innovation if they do not invent anymore when they have invented before.

After considering separately the effect of both innovation and export strategies on TFP, we have investigated the joint effect of persistence in both innovation and exporting, using two different dataset: one with only persistent exporters (firms that have exported permanently over the time-span) and non-persistent exporters (or temporary, firms that started or stopped exporting in the period considered).

Our aim was to see if different strategies in innovation or in export may have a different effect on TFP and if this effect is boosted by the joint effect of persistence in both strategies.

When we consider the strategies separately, their effects are not significant and they do not allow firms to gain productivity. Moreover, firms' permanent efforts in innovation activities have a positive and significant impact on TFP only if they are associated with a likewise enduring export activity, otherwise they could have a negative effect on productivity. This could be due to the crucial role in internalizing knowledge flows from long-lasting (and not occasional) interactions with foreign customers and competitors deriving from exporting regularly. If combining both strategies can be an opportunity for even older firms that can face the fiercer competition from younger, by contrast, not undertaking both strategies could transform persistent innovation in a factor of weakness for firms, even if they try to provide for it by internal R&D. Innovation activities, as said, are costly and the existence of start-up costs could "imprison" firms in a sort of state-dependence (or inter-temporal stability) in innovation efforts.

In conclusion, the most relevant results of our estimations are in favor of the hypotheses that persistently innovating *and* persistently exporting firms have better results in terms of productivity than persistently exporting firms that do not innovate persistently and than firms that do not export

persistently. Furthermore, persistent innovation efforts must be associated with a permanent presence on foreign markets, to not transform opportunities in threats.

Appendix A1

In Table A1 there are summary statistics of the Balanced Panel.

Table A1 - Summary statistics: Balanced Panel

	No distinction among exporters				
	Obs.	**Mean**	**Std. Dev.**	**Min**	**Max**
TFP[a]	1173	10,037	2,011	3,086	16,42
Pers. Innov	1353	0,308	0,462	0	1
Start Innov	1353	0,135	0,342	0	1
Stop Innov	1353	0,112	0,315	0	1
Inves. ITC	1194	0,821	0,384	0	1
Inves. R&D	1322	0,573	0,495	0	1
FDI	924	0,044	0,206	0	1
ForOwn	1353	0,059	0,236	0	1
Group	1346	0,26	0,439	0	1
Age	1349	32,98	19,76	0	232
Size[b]	1332	183,81	618,05	4	9097,3

[a] The productivity is computed a la Levinsohn-Petrin.
[b] The size is computed as the average number of employees.
For the sake of brevity, industry and area dummies are not displayed.
Source: own calculation

Appendix A2

Epanenchnikov kernel estimations. The bandwidth is set according to the "optimal" rule from Silverman (1986).

Figure A1 - Kernel densities of age (in log) for persistent exporters (left) and non-persistent exporters (right), by different innovation strategies.

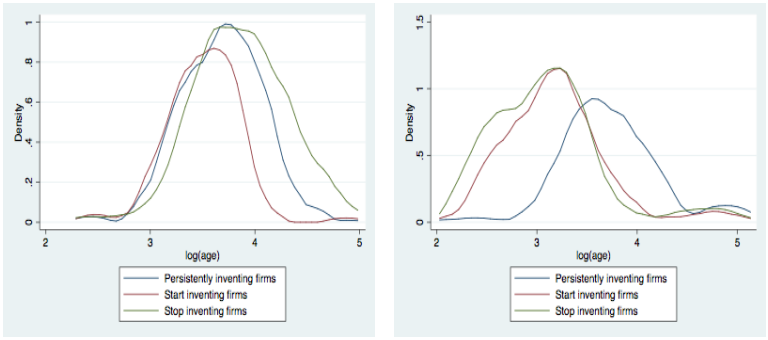


Figure A2 - Kernel densities of total factor productivity (TFP) for persistent exporters (left) and non-persistent exporters (right), by different innovation strategies.

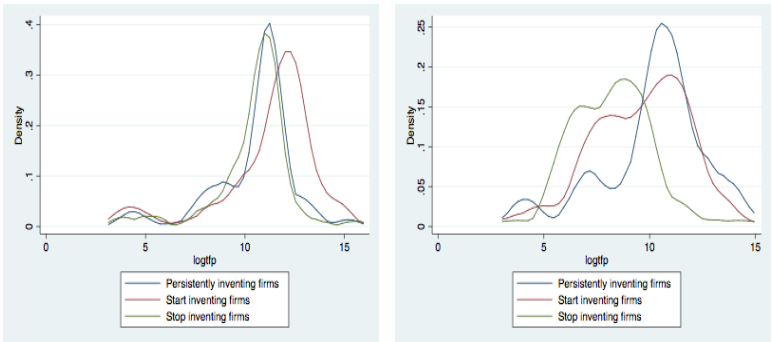
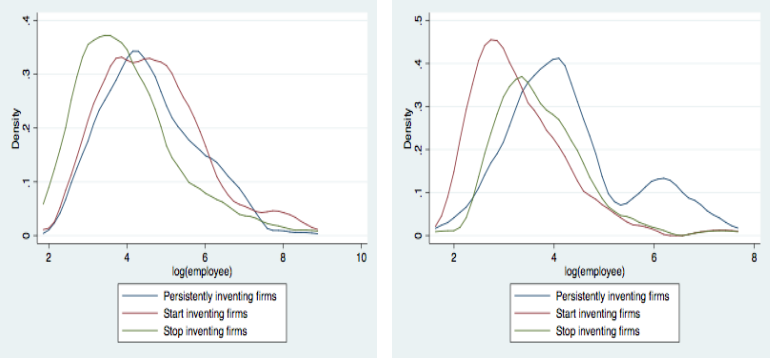


Figure A3 - Kernel densities of average number of employees (in log) for persistent exporters (left) and non-persistent exporters (right), by different innovation strategies.



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