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

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This paper investigates the idea that firms can learn to innovate from international activities and that their innovation performance is influenced by the links they have with foreign markets. By using micro data from Italy we aim to shed additional light on the relationship between different internationalization strategies and innovation. We want to contribute to the strand of literature named LIBE (learning-to-innovate-by-exporting); however, we further extend this approach taking into account the different level of complexity concerning internationalization strategies, identifying which channel (focusing on exports, FDI and outsourcing) has a stronger impact on firms' innovation performance. First we implement a probit estimation; secondly, we will cope with endogeneity and selection issues by implementing a propensity score matching (PSM). We find that it is possible to suppose the existence of a "hierarchy" among the different strategies considered: FDI is the strategy ensuring the higher return in terms of innovation of any type, while exports in the case of product innovation. On the contrary, outsourcing is the less rewarding strategy. Another important contribution of our work is to consider how exporting, investing or outsourcing in different destination countries may affect the innovation outcome.We find that investing in non-European industrialized countries has a positive impact on innovation; moreover, firms exporting in non-industrialized countries may benefit in terms of innovation more than firms that export in more developed countries.

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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 a probit adopting 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[1]. We merge the three waves and this gives us a balanced panel of more than 19.000 observations[2].

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[3].

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[4].

Merging the three waves our final estimation panel (EP) turns out to keep all the informations contained in the different waves.

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[1] 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.

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

[3] 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.

[4] See Chapter 1 for further details).

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

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

ATECO classification (2 digit)	Freq.	Percent.	Cum.
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	

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

Classes (by number of employees)*	Freq.	Percent	Cum.
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[5], 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. 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).

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

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

[5] 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.

(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.

Table 4 - Forms of internationalization and firms characteristics - means

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	63.804,08	76.278,83	5.074	51.643,54	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

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 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%).

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)

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 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*).
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*)[6].

Table 7 - Variables description

Variable	Obs	Mean	Std. Dev.	Min	Max
innov	13628	0,547	0,498	0	1
innovprod	13628	0,399	0,489	0	1
_ha_expor	3648	0,727	0,446	0	1
_FDI	3099	0,029	0,169	0	1
_outsourcing	3146	0,159	0,365	0	1
lage	13819	3,564	0,453	2,197	5,789
_isgroup	3651	0,272	0,445	0	1
_capintensity	3183	32,474	86,680	0	2792,47
_VAempl	3218	46000,730	23920,210	2084,179	472.623,5
_hares	3584	0,446	0,497	0	1
_sogestr_ctrll	4078	0,064	0,245	0	1

[6] 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).

Variable	Obs	Mean	Std. Dev.	Min	Max
_patents	3571	0,023	0,149	0	1

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).
At this stage we run three different random effect probit estimation for the three different strategies considered. The equation[7] we want to estimate is the following:

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

According to the innovation type considered, the dependent ($Innov_{it}$) will be any type of innovation or product innovation and the main independent ($strateg_{it}$) will likewise change in accordance with the internationalization strategies considered (*_ha_expor, _FDI, _outsourcing*).
The results[8] in Table 10 indicate similar results to Table 9, since the positive and significant coefficient of FDI is higher than the exporting and outsourcing coefficients, that are quite similar and significant as well.

Table 10 - Probit estimation results for any type of innovation

The impact on innovation of any type

	(1)	M.E.(1)	(2)	M.E.(2)	(3)	M.E.(3)
Export	0.2605*** (0.072)	(0.0864)				
FDI			0.460** (0.2172)	(0.1534)		
Outsourcing					0.277*** (0.088)	(0.092)
lage	0.05084 (0.0773)	(0.0169)	0.0294 (0.0775)	(0.0098)	0.0358 (0.077)	(0.0119)
_isgruppo	0.0601 (0.0819)	(0.0199)	0.0369 (0.082)	(0.0123)	0.0454 (0.0816)	(0.0151)
_capintensity	-0.00328*** (0.0006)	(-0.0011)	-0.0032*** (0.0006)	(-0.0011)	-0.0032*** (0.0006)	(-0.001)

[7] We present probit equation with RE using as dependent the innovation. When we estimate the other types of innovation, we change the dependent variable.

[8] In this table, for the sake of brevity, we do not show the results for the sector and region.

The impact on innovation of any type

	(1)	M.E.(1)	(2)	M.E.(2)	(3)	M.E.(3)
_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	0.7172*** (0.0671)	(0.2381)	0.757*** (0.066)	(252)	0.72*** (0.067)	(0.239)
sogestr ctrl	-0.0837 (0.143)	(-0.0278)	-0.0796 (0.1437)	(-0.0258)	-0.083 (0.142)	(-0.027)
_patents	-0.103 (0.218)	(-0.034)	-0.0985 (0.219)	(-0.0328)	-0.15 (0.219)	(-0.05)
dimension (number of employees)						
20-49	0.1675** (0.0785)	(0.0583)	0.1835** (0.0782)	(0.064)	0.181** (0.0782)	(0.061)
50-249	0.4429*** (0.0873)	((0.154)	0.472*** (0.0867)	(0.164)	0.472*** (0.0866)	(0.164)
>=250	0.699*** (0.1368)	(238)	0.7199*** (0.137)	(0.246)	0.724*** (0.136)	(0.247)
Industry	(Yes)		(Yes)		(Yes)	
Region	(Yes)		(Yes)		(Yes)	
cons	-8.0135***		-7.967***		-7.845***	
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. Marginal Effects in columns M.E.

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 and also the hypothesis that firms investing abroad have a return in terms of knowledge enhancing their innovation activity. Moreover, the FDI seems to have a bigger positive impact on innovation activity than the export and the positive and 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.

Furthermore, the results show that older firms and firms that are part of a group are more inclined to introduce innovation while the lagged capital intensity has a negative and significant effect (although very small) on innovation. The negative and significant capital intensity coefficient suggests, instead, the explanation that more innovative firms are characterized by a

high level of intangible assets more than being capital intensive.As expected, if the firm has invested in R&D in the previous period, it is more likely to introduce innovation in the following, while if it has acquired patents from outside, this kind of activity clearly replace internal innovation.
Finally, foreign owned firms seem to be less innovative than domestic ones. One possible explanation could be that MNE own Italian firms for less technological based activities keeping their core activities, more technology-led, in home plants.
If we consider product innovation as a measure of innovation (Table 11), the FDI is not significant (while it was significant for innovation of any type), while the coefficient of exports is the higher and significant. The outsourcing strategy, in this case, has to have the smallest impact and with weak significance.

Table 11 - Probit estimation results for product innovation

The impact on product innovation

	(1)	M.E.(1)	(2)	M.E.(2)	(3)	M.E.(3)
Export	0.3131*** (0.079)	(0.1055)				
FDI			0.2166 (0.2069)	(0.073)		
Outsourcing					0.205** (0.092)	(0.069)
lage	0.02382 (0.0801)	(0.008)	0.0145 (0.0821)	(0.005)	0.0131 (0.082)	(0.0044)
_isgruppo	0.0409 (0.0846)	(0.0138)	0.0286 (0.086)	(0.009)	0.0291 (0.0866)	(0.0098)
_capintensity	-0.00171*** (0.0006)	(-0.0006)	-0.0017*** (0.0006)	(-0.0006)	-0.0017** (0.0006)	(-0.0005)
_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	0.6559*** (0.0770)	(0.221)	0.713*** (0.079)	(0.240)	0.686*** (0.079)	(0.23)
_sogestr_ctrl	-0.0556 (0.146)	(-0.0187)	-0.057 (0.1505)	(-0.019)	-0.052 (0.150)	(-0.0174)
_patents	0.00139 (0.222)	(0.0005)	0.0173 (0.228)	(0.006)	-0.0278 (0.229)	(-0.009)
dimension (number of employees)						
20-49	0.1049 (0.0833)	(0.0358)	0.1242 (0.085)	(0.0425)	0.127 (0.085)	(0.043)

The impact on product innovation

	(1)	M.E.(1)	(2)	M.E.(2)	(3)	M.E.(3)
50-249	0.2196** (0.0925)	(0.0756)	0.254*** (0.0944)	(0.0876)	0.261*** (0.0946)	(0.089)
>=250	0.488*** (0.1431)	(0.168)	0.532*** (0.147)	(0.184)	0.538*** (0.147)	(0.185)
Industry	(Yes)		(Yes)		(Yes)	
Region	(Yes)		(Yes)		(Yes)	
cons	-6.23		-6.639		-6.63	
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. Marginal Effects in columns M.E.

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)[9].

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 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[10]) strategy and we restrict the sample to the common support area by using a caliper of 0.01[11].

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*).

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

[10] 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.

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

In the Table 12, we present the results of the three different matching estimations, measuring the ATT[12].

Table 13- 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 and an even higher probability is shown by the firms that have implemented a FDI strategy (25,9%). The outsourcing strategy, instead, ensures the lowest probability of innovating (2.67%).

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.

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

[12] 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.

coefficient) positive possibility, and it is greater compared to outsourcers, of introducing product innovation.

Table 14 - 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, instead, FDI is the strategy that ensures the higher positive probability of introducing innovation. But all the strategies loose their significance.

Table 15 - 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[13]; non-European industrialized countries; non-European non industrialized countries).

Table 16 - 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)

Looking at Table 14, 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.

[13] 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.

If we apply the same propensity score matching strategies as before considering the destinations[14], we can see (Table 15) 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.

Table 17 - 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

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

	EU 15			
Internationalization strategy	**ATT**	**SE**	**Number of treated**	**Number of controls**
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 16), 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.

Table 17 - 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				

	Product Innovation				Process Innovation			
	EU 15							
Intern. strategy	**ATT**	**SE**	**N. of treat.**	**N. contr.**	**ATT**	**SE**	**N. of treat.**	**N. contr.**
	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.

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).

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: 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, probit estimation and then a propensity score matching procedure and 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 that seems to have even an higher impact on the probability of introducing innovation 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 probit estimation, Heckman, and also 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[15] (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

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.

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

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

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	0,498 5865	4156	0,420 5967	0,493 7143	4848	0,665 0165	0,472 0334
innovprod	4624	0,253	0,434 6708	4156	0,420 5967	0,493 7143	4848	0,519 5957	0,499 6674
ha_expor	4680	0,667	0,471 2277	4249	0,747 2346	0,434 6487	5104	0,619 906	0,485 4572
FDI	4680	0,021	0,144 6216	4125	0,034 9091	0,183 5718	273	0,139 1941	0,346 7847

	1998-2000			2001-2003			2004-2006		
Variable	**Obs**	**Mean**	**Std. Dev.**	**Obs**	**Mean**	**Std. Dev.**	**Obs**	**Mean**	**Std. Dev.**
outsourcing	4680	0,011	0,319 0044	4151	0,075 4035	0,264 0731	5137	0,070 4691	0,255 9609
lage	4643	3,602	0,379 19	4115	3,623	0,418	5061	3,482	0,524
isgroup	4671	0,204	0,402 873	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

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:

$$0 < P(D = 1 \mid X) < 1$$

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.

		The impact on innovation				
Variable	**Unm. vs Match.**	**Mean Treated Control**	**%bias**	**%reduct bias**	**t-test t p>t**	**V(T)/ V(C)**
lage	U	3,666 3,634	7,7		1,53 0,126	1,35*
	M	3,666 3,722	-13,9	-79,9	-3,33 0,001	0,95
_isgruppo	U	0,267 0,18	21,5		4,25 0,000	1,33*

The impact on innovation

Variable	Unm. vs Match.	Mean Treated Control	%bias	%reduct bias	t-test t p>t	V(T)/ V(C)
	M	0,254 0,2	13,0	39,4	3,36 0,001	1,18*
_capintensity	U	26,705 31,603	-7,8		-1,69 0,09	0,59*
	M	26,482 29,432	-4,7	39,8	-1,37 0,17	0,86*
_VAempl	U	47951 41596	30,2		5,99 0,00	1,29*
	M	47212 46708	2,4	92,1	0,59 0,553	0,88*
_hares	U	0,523 0,198	71,7		13,97 0.00	1,56*
	M	0,506 0,502	0,8	98,9	0,19 0.847	1,00
_sogestr_ctrl	U	0,065 0,032	15,2		2,92 0.004	1,94*
	M	0,056 0,033	10,7	29,8	2,91 0,004	1,66*
_patents	U	0,029 0,005	18,7		3,35 0,001	5,60*
	M	0,02 0,009	8,0	57,2	2,23 0.026	2,06*
2.dim	U	0,322 0,389	-14,0		-2,88 0.00	0,92
	M	0,332 0,318	2,9	79,0	0,78 0.435	1,02
3.dim	U	0,338 0,188	34,5		6,77 0.000	1,46*
	M	0,337 0,332	1,2	96,5	0,29 0.775	1,01
4.dim	U	0,118 0,035	31,2		5,79 0.000	3,02*
	M	0,101 0,108	-2,5	91,9	-0,57 0.57	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.

The impact on 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

The impact on innovation

Variable	Unm. vs Match.	Mean Treated Control	%bias	%reduct bias	t-test t p>t	V(T)/ V(C)
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

The impact 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

The impact on innovation

Variable	Unm. vs Match.	Mean Treated Control	%bias	%reduct bias	t-test t p>t	V(T)/ V(C)
_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.

The impact 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*

The impact on innovation

Variable	Unm. vs Match.	Mean Treated Control	%bias	%reduct bias	t-test t p>t	V(T)/ V(C)
	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.

The impact on 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

The impact on innovation						
Variable	**Unm. vs Match.**	**Mean Treated Control**	**%bias**	**%reduct bias**	**t-test t p>t**	**V(T)/ V(C)**
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

The impact on 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

The impact on innovation

Variable	Unmatched Matched	Mean Treated Control	%bias	%reduct bias	t-test t p>t	V(T)/ V(C)
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

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

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

Table A13 - Heckman for any type of innovation

The impact on innovation

	(1)	**M.E.(1)**	**(2)**	**M.E.(2)**	**(3)**	**M.E.(3)**
Export	0.264*** (0.073)	0.087				
FDI			0.461** (0.216)	0.154		
Outsourcing					0.293*** (0.088)	0.097
lage	0.0455 (0.07)	0.015	0.021 (0.077)	0.007	0.0026 (0.077)	0.008
_isgruppo	0.0636 (0.082)	0.0211	0.032 (0.082)	0.011	0.039 (0.081)	0.0131
_capintensity	-0.0033*** (0.0006)	-0.00109	-0.0032*** (0.0007)	-0.0011	-0.003*** (0.0007)	-0.001
_VAempl	2.59e-06 (1.60e-06)	8.6e-07	2.92e-06* (1.59e-06)	9.73e-07	2.69e-06* 1.59e-06	8.97e-07
_hares	0.713*** (0.067)	0.237	0.752*** (0.066)	0.250	0.713*** (0.067)	0.237
_sogestr_ctrl	-0.072 (0.143)	-0.024	-0.066 (0.144)	-0.0219	-0.072 (0.143)	-0.0238
_patents	-0.101 (0.218)	-0.033	-0.097 (0.22)	-0.032	-0.153 (0.219)	-0.05
dimension (n. of employees)						
20-49	0.171** (0.078)	0.059	0.188** (0.078)	0.065	0.185** (0.0786)	0.065
50-249	0.434*** (0.087)	0.15	0.468*** (0.087)	0.163	0.469*** (0.087)	0.163
>=250	0.678*** (0.137)	0.231	0.71*** (0.137)	0.243	0.716*** (0.137)	0.245
Industry	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)
Region	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)

The impact on innovation

	(1)	M.E.(1)	(2)	M.E.(2)	(3)	M.E.(3)
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. Marginal Effects in columns M.E.

Table A14 - Heckman for product innovation

The impact on innovation

	(1)	M.E.(1)	(2)	M.E.(2)	(3)	M.E.(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	

The impact on innovation

	(1)	M.E.(1)	(2)	M.E.(2)	(3)	M.E.(3)
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. Marginal Effects in columns M.E.

Table A15 - Heckman for process innovation

The impact on innovation

	(1)	M.E.(1)	(2)	M.E.(2)	(3)	M.E.(3)
Export	0.266 (0.239)	0,039				
FDI			0.478 (0.564)	0,070		
Outsourc.					0.269** (0.084)	0.068
lage	0.555** (0.215)	0,081	0.413** (0.207)	0,061	0.003 (0.075)	0.001
_isgruppo	-0.018 (0.233)	-0,003	-0.061 (0.232)	-0,009	0.0178 (0.079)	0.006
_capintensity	-2.622*** (0.924)	-0,383	-2.499*** (0.910)	-0.367	-0.0016*** (0.0006)	-0.0005
_VAempl	0.000 (0.000)	3.66e-07	0.000 (0.000)	4.71e-07	2.76e-06** (1.55e-06)	9.48e-06
_hares	0.360* (0.193)	0,056	0.419** (0.190)	0,062	0.64*** (0.066)	0.22
_sogestr_ctrl	0.073 (0.433)	0,011	0.022 (0.442)	0,003	-0.032 (0.138)	-0.011
_patents	-0.269 (0.603)	-0,039	-0.269 (0.610)	-0,039	-0.023 (0.21)	-0.008
dimension (n. of employees)						
20-49	0.073 (0.269)	0,011	0.142 (0.268)	0,021	0.126 (0.078)	0.044
50-249	0.258 (0.267)	0,039	0.318 (0.263)	0,048	0.244*** (0.086)	0.0855
>=250	0.644* (0.335)	0,094	0.773** (0.334)	0,113	0.489*** (0.131)	0.172
Industry	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)
Region	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)	(Yes)
cons	-1,108*		-5,364		-5,350	

The impact on innovation

	(1)	M.E.(1)	(2)	M.E.(2)	(3)	M.E.(3)
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. Marginal Effects in columns M.E.

A6: PSM for different destinations.

Table 16 - Strategies/Destinations (PSM caliper KERNEL)

		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 18 - Strategies/Destinations (PSM caliper KERNEL) product

		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 20 - Strategies/Destinations (PSM caliper KERNEL) process

		EU 15		
Internationalization 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

	EU 15			
Internationalization strategy	**ATT**	**SE**	**Number of treated**	**Number of controls**
	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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