Innovation activities and Italian SMEs' exports decisions: a multi-treatment analysis

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Abstract: This study aims at estimating the effect of innovation on export growth for a sample of Italian small and medium size manufacturing firms. We define two classes of innovation, namely technological and non-technological. For each class of innovation, we use a propensity score matching strategy to assess if innovating in period $t-1$ led to an increase in firms' probability of seeking for new exporting markets in period $t+1$. Moreover, we assess the combined effect of both classes of innovation upon the probability of seeking for new markets. We found that both technological and non-technological innovations increases the probability that a firm will plan to look for new markets abroad, the former type of innovation being, on average, twice as relevant as the latter. Moreover, we found evidence that these are complementary activities, which are more effective on future exports decisions when combined.

Keywords: exports; innovation; small and medium enterprises; propensity score matching; PSM.

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1 Introduction

The relevance of innovating activities for gaining competitiveness in international markets has recently attracted much attention both among scholars and policy analysts (see among others, WTO, 2008). One of the dominant ideas in trade literature is that innovative firms self-select to operate in international markets whereas less innovative firms are unable or unwilling to penetrate foreign markets. This hypothesis typically goes through productivity gaps and sunk-costs theory: only those firms who are efficient enough to bear entry costs and intense competition in the export market might gain momentum in international markets.[1] In turn, the underlying mechanism for the selection of most efficient firms into foreign markets relates to firm's investment decisions [Cassiman et al., (2010), p.372] and specifically to investments in innovative activities. The idea is that a firm that wants to export works hard to satisfy international buyers. Firms then make investment decisions just for that purpose, intentionally increasing their 'technological' effort (Razzak, 2008). In fact, several empirical studies have documented a positive correlation between investment in R&D and exporting using micro-level data (see among others, Aw et al., 2007; Cassiman and Martınez-Ros, 2007; Girma et al., 2008; Iacovone and Javorcik, 2010).

In this study, we address the innovation and exports linkage for small and medium enterprises explicitly taking into account the endogenous nature of innovation when explaining exports. Moreover, we look at the effect of alternative forms of innovation on the probability that a firm will seek for new markets to export. The novelty of our contribution rests mainly on the attention we pay in defining innovation activities when assessing their impact on exports behaviours. In fact, the traditional concept of innovation typically distinguishes between product and process innovation. Since both are associated with the development or application of new technologies, these innovations are often called technological innovations. However, this traditional view of innovation ignores important elements of non-technological innovative activities that are often undertaken by innovating firms (e.g., adopting new business routines, re-organise existing ones, improving external relations and introducing new marketing strategies). This criticism prompted us to embrace a broader definition of innovation, which includes non-technological innovations alongside technological innovations (Schmidt and Rammer, 2007).

Building on this new view, we define two classes of innovation strategies – i.e., technological and non-technological innovations – and for each class we use a propensity score matching (PSM) strategy to assess which form of innovation leads to a higher increase in the probability of seeking for new exporting markets. Technological innovations include product and process innovation while non-technological innovations include organisational and marketing innovations. The main findings we obtained for a representative sample of Italian small and medium enterprises can be summarised as follows: non-technological innovations increase the probability of looking for new markets abroad by 12.5 percentage points while technological innovations increase such probability by 8.7 percentage points. However, a firm that incurs both forms of innovation at the same time will increase the odds of reporting plans to increase its export by 18.2 percentage points.

The remainder of the paper proceeds as follows. In Section 2, we provide an overview of earlier theoretical and empirical studies on innovation and exports. Section 3 describes the methodology and the data used in the study. Section 4 provides results and Section 5 concludes.

2 Innovation and exports: an overview of the literature

In this section, we provide a concise review of the literature on the causal relation between innovation and exports. Additionally, we review the classification of innovation into technological and non-technological activities.

2.1 On the innovation and exports linkage

The theoretical foundation of the innovation and exports linkage rests on early macro trade theory models and specifically on the North-South product-cycle proposition (see, for instance, Vernon, 1966; Krugman, 1979; Dollar, 1986). In a Vernon-type product-cycles model, the geographical dimension refers mainly to cross-countries differences in the production system: the North is distinguished from the South by its superior ability of innovation and higher wage rate. Additionally, the production process in these models generally consists of two stages, R&D and manufacturing. The basic prediction of these models is that Northern countries specialise in the production and export of innovative goods, which are later imitated by Southern countries as product characteristics get more standardised and a dominant design develops. At this stage of the product cycle, competition shifts to manufacturing efficiency rather than developing new product characteristics, and low wage regions exploit their relative advantage. Eventually, Southern countries will export these goods back to the North and push developed countries to introduce new innovations to keep up their exports (Lachenmaier and Wößmann, 2006). In short, Northern countries (whose comparative advantage rests on the production of new and technologically advanced products) must innovate continuously to penetrate international markets and oppose the tough competition of Southern countries.

The outcome of these early macro trade models has been recently taken up by 'new' new trade theory models. Building on firm heterogeneity, Melitz (2003) and Bernard et al. (2003) developed a new class of trade models where only highly productive firms are engaged in exporting. The underlying idea of Melitz (2003) is that firms have a heterogeneous level of productivity and only highly productive firms are able to make sufficient profits to cover the large fixed costs required for exports. In this regard, being present in international markets becomes a task closely related with productivity levels. Bernard et al. (2003) assume heterogeneity of plants introducing Ricardian differences in technological efficiency across producers and countries. In a Bertrand competition framework between heterogeneous firms, only the most productive enterprises can cover the transportation costs associated with international trade. Therefore, both models find that more productive firms self-select into export markets and display considerable persistence in doing so (Cassiman and Martínez-Ros, 2007).

Although very relevant, these models fall short of explaining why some firms are more productive than others and select into international markets[2] – i.e., the missing link is what determines productivity gaps across firms operating in the same country and in the same industry. As put by Cassiman et al. (2010, p.372) "These models […] assume that the productivity distribution across firms is exogenous to firms, thus relating firm survival to luck-of-draw. Firms with low productivity exit, while 'lucky' firms with high productivity survive and continue growing. Little room is left for "*firm decisions*"". This is where innovation decisions come about. Only those firms who decide to invest in innovation activities gain in productivity and succeed to self-select into international markets. Hence, it becomes crucial to provide a fine-grained definition of various innovation activities undertaken by entrepreneurs, and establish their link with firm productivity.

2.2 Technological and non-technological innovation activities

Starting from the early 90s, many firms operating in Northern countries (remarkably in the USA) experienced a notable increase in their productivity levels. Inklaar et al. (2008) show that US GDP per hour growth accelerated from 1.3% 1980–1995 to 2.2% 1995–2006. While attempting to explain such trend, analysts and economists focused their attention on the emergence of a 'new economy' characterised by firms increasing their capital investments, especially in information technology (IT) software and hardware (Black and Lynch, 2004). In fact, decompositions of US productivity growth show that a large fraction of this recent growth occurred in those sectors that either produce IT or intensively use IT (Bloom et al., 2012).

However, a heated debate has surrounded the question as to the extent to which investments in IT have indeed contributed to the so-called productivity miracle. Earlier studies seemed to suggest a low or no intake of such investments in terms of productivity and profitability of companies (see Loveman, 1994; Barua et al., 1995) or that the marginal benefit of investments in computers were below its marginal cost (e.g., Morison and Berndt, 1990).[3] This finding gave rise to a heated debate, which developed into more thorough empirical and theoretical investigations. Brynjolfsson (1993) identified four possible explanations for early disappointing results:

1 incorrect measurement of input and output

2 lags between the time in which IT investments are undertaken and when the positive effects of these investments occur (the delay is due to the necessary time required to learn and adapt to new conditions)

3 redistribution and dissipation of the profits generated from investments in IT

4 poor management of new IT technologies.

Moving along this controversial line of investigation, several authors explain the importance of IT by investigating its combined effect with organisational innovation (see e.g., Brynjolfsson and Hitt, 2000; Bresnahan et al., 2002). Case studies reveal that the introduction of IT has often been combined with a transformation of the firm, investment in intangible assets, and a change in the relation with suppliers and customers. IT offers the possibility for flexible production (e.g., just-in-time inventory management, integration of sales with production planning, etc.); however, such new production strategies need to be combined with adequate managerial and workplace reorganisation strategies to be effective. In one of the few empirical studies of investments in information technologies and organisational change, Bresnahan et al. (2002) find evidence for complementarities between technology, organisational changes and workforce skills. Mostly, the available econometric evidence at the firm level shows that a combination of investment in IT and changes in organisational and work related practices facilitated by these technologies contributes to the firm's productivity growth (see Polder et al., 2010).

Hence, productivity gains appear to be determined by innovation activities, but it is not just a question of introducing new IT-based processes and/or new products; it is rather the combination of both technological and non-technological innovation activities, which determines productivity gains.

In fact, as it was observed by Schmidt and Rammer (2007) that the introduction of product and/or process innovations (i.e., technological innovations) often demands:

1 reorganising business routines, which may trigger the introduction of new business practices or new organisational models

2 the establishment of new production or sales divisions, which call for re-organisation of workflows, knowledge management or external relations

3 new marketing strategies or approaches.

In conclusion, technological and non-technological innovations should not be conceived as alternative activities; these are rather complementary strategies, which are more effective when combined. We will attempt to test this complementarity hypothesis in our empirical investigation.

3 Methodology and data description

As mentioned in the introduction, this study looks at the effect of alternative forms of innovation on the probability that a firm will seek for new markets to export. However, it is worth noticing that the causal relation between innovation and export might run the opposite way since intended and unintended international knowledge flows might stimulate the post-entry innovative performance of firms.[4] The presence of reverse causality undermines the possibility to conduct sound empirical tests to disentangle the direction of causality between innovation and exports employing conventional parametric techniques. Typically, endogeneity is solved using instrumental variable procedures (2SLS). However, the 2SLS is not without shortcomings. First, it is difficult to find instruments that are both strong and valid. Second, the 2SLS can only provide an estimate of the local average treatment effect, and as such the results cannot be generalised to the entire population unless one is willing to make some strong behavioural assumptions (Heckman et al., 1997). An alternative to the 2SLS, which will be employed in this paper, is the PSM, a methodology which has gained momentum in the past few years (Guo and Fraser, 2009).

To that regard, this study belongs to a larger literature on the Average effect of the Treatment on the Treated group (ATT), where the treatment is the innovation undertaken by the firm. The usual problem associated with the estimation of the ATT is that the natural counterfactual for a treated observation, i.e., the outcome associated with the treated firm if it were not treated, is not available. For this reason, an OLS estimation of the ATT is likely to be biased if treated and untreated firms differ systematically and this unobserved heterogeneity is correlated with the outcome of the treatment (e.g., firm's productivity). The PSM draws on the idea that ATT can be retrieved by comparing a treated observation with a non-treated observation with a similar distribution of observed variables before the treatment. The assumption underlying PSM is that firms with similar observable covariates will be similar also on the unobservables. The PSM is a way to reduce the dimension of all observable covariates to just a scalar (Rosenbaum and Rubin, 1985). This approach has been used before to study the relationship between innovation and export (Hanley and Monreal-Perez, 2011; Palangkaraya, 2012). This study is different from the previous body of work in that we differentiate between types of innovation.

The data used for this study is taken from the Indagine Tagliacarne, 2004. This dataset contains detailed information about 2,603 manufacturing Italian firms with less than 250 employees. About 60% of the sample consists of micro firms (i.e., firms with less than 10 employees). Small firms (i.e., firms with 10 to 50 employees) account for 25% of the sample and medium size firms account for the remaining part. Respondents were asked to indicate whether in the two years before the survey the firm engaged in any of the following four forms of innovations: product innovation, process innovation, organisational innovation, and marketing innovation. Multiple answers are allowed, while no answer indicates that no form of innovation took place.

Since each firm faces multiple innovation choices, the propensity score is better estimated using a multinomial logit (Lechner, 2001). Becker and Egger (2009) used a similar approach to analyse the relative impact of product and process innovation on the propensity to export. We build upon their model and we add two more forms of innovation: organisational and marketing innovation. Each firm can undertake more than one treatment, but categories in the multinomial logit cannot be overlapping. Therefore, the multinomial logit should not be specified only over five outcomes (with no innovation serving as a reference group), but over 16 possible innovation strategy combinations. However, it is not feasible to estimate a propensity score with so many outcomes. Hence, we collapse the first two forms of innovation (product and process) into one category that we call *technological innovation*, and the organisational and marketing innovation into *non-technological innovation*. We then group firms according to one of the four possible mutually exclusive treatments: firms that do not engage in any form of innovation, firms that engage only in non-technological innovation, firms that engage only in technological innovation, and firms that engage in both technological and non-technological innovations. The survey asked firms whether they plan on seeking new markets abroad in the two years following the interview. In Table 1, we show the percentage of firms responding affirmatively to the question within each one of the four innovation strategies identified above.

Table 1 Innovation and export strategy

Innovation strategy	*% of firms looking for new markets to export*	
	Entire sample	*Non-exporting firms*
No innovation	12.6	4.4
	N = 1,224	*N* = 1,030
Technological innovation only	30.6	23.8
	N = 752	*N* = 130
Non-technological innovation only	37.2	13.2
	N = 188	*N* = 515
Tech. and non-tech. innovation	50.6	23.7
	N = 439	*N* = 211

Only 12% of the firms that did not engage in any form of innovation were planning to expand their markets abroad, compared to more than 50% of firms that experiences both technological and non-technological innovation. Seeking new markets abroad is more prevalent among firms that took on a non-technological innovation in the entire sample. When restricting the sample to currently non-exporting firms, technological innovation seems the more relevant form of innovation for exporting in the future. While Table 1 suggests that innovation is correlated with seeking new markets abroad, it cannot unveil the magnitude of the true causal effect.

In the PSM analysis, firms who innovate (treatment group) are not directly compared to firms that do not innovate (control group), but only to firm that do not innovate with similar propensity scores. The fact that the non-treatment group is always larger than any treated group is important to insure that the common support requirement between treated and non-treated observations will be respected. Several algorithms can be used to match an observation in the treatment group with an observation in the non-treatment group. With no agreement in the literature about which matching algorithm should be preferred, we use the three standard matching algorithms: Kernel, 1-to-1, and radius. In the Kernel-based matching algorithm, each firm in the treatment group is matched to a weighted sum of firms who have similar propensity scores with the greatest weight given to firms with closer scores. In the 1-to-1 matching algorithm, each firm in the treatment group is matched to the firm with the closest score in the control group. In the radius matching algorithm, each firm in the treatment group is matched to firms in the control group with a score within a pre-set interval. In the latter case, we experiment with three different cut-off points: we use a radius of 0.1, 0.05, and 0.01.

Table 2 Descriptive statistics

Variable	*Firm will NOT seek new markets abroad*		*Firm will seek new markets abroad*	
	Mean	*Std. dev.*	*Mean*	*Std. dev.*
Technical innovation	0.383	0.486	0.669	0.471
Non-technical innovation	0.174	0.379	0.432	0.496
Type of market served ('regional and national market' is the reference category)				
International export	0.122	0.327	0.713	0.453
Local market	0.532	0.499	0.223	0.417
Quality ('high' is the reference category)				
Medium high	0.223	0.416	0.422	0.494
Medium	0.594	0.491	0.388	0.488
Medium low	0.071	0.256	0.058	0.233
Low	0.034	0.181	0.018	0.132
Revenues ('< 300,000 euros' is the reference category)				
From 300,000 to 1 million €	0.268	0.443	0.277	0.448
From 1 to 5 million €	0.181	0.385	0.254	0.436
From 5 to 10 million €	0.031	0.172	0.092	0.289
> 10 million €	0.031	0.172	0.169	0.375
Geography ('south' is the reference category)				
North	0.580	0.494	0.638	0.481
Middle	0.188	0.391	0.183	0.387
Year of establishment ('before 1960' is the reference category)				
Between 1961 and 1970	0.095	0.293	0.142	0.349
Between 1971 and 1980	0.216	0.412	0.225	0.418
Between 1981 and 1990	0.321	0.467	0.232	0.423
Between 1991 and 2000	0.253	0.435	0.231	0.422
After 2000	0.051	0.220	0.040	0.196
Sector ('food and beverage' is the reference category)				
Clothing	0.132	0.339	0.126	0.332
Footwear and leather	0.035	0.185	0.047	0.213
Wood and furniture	0.139	0.346	0.093	0.291
Chemical and plastic	0.048	0.214	0.072	0.259
Mineral	0.057	0.231	0.036	0.185
Metal	0.180	0.384	0.191	0.393
Mechanical	0.077	0.267	0.136	0.343
Electrical	0.094	0.292	0.093	0.291
Other	0.112	0.315	0.087	0.282
N obs	1927		676	

The propensity score is estimated using the following multinomial logit model:

$$\Pr(Y_i = j) = f\left(Market_{ij}, Quality_{ij}, Size_{ij}, Location_{ij}, Age_{ij}, Sector_{ij}\right)$$

where *i* represents the individual firm and *j* one of the four innovation states. We model the propensity to innovate as a function of type of market served (*Market*), the quality of the good produced (*Quality*), the firm's size (*Size*), the age of the firm (*Age*), the geographical location (*Location*), and the sector of operation (*Sector*). The type of market served (local, regional and/or national, international) is used to control for whether the firm is already a player in the international market (learning-by-exporting effect). The quality of the good produced captures the idea that high quality product require larger investments in innovation (Lin and Lu, 2006). Previous studies have shown that both the firm's size and age affect the probability of innovating (Hansen, 1992). We control for the firm's size using five revenue categories. Finally, we control for the firm's location and sector of operation to capture regional and industrial differences in the propensity to innovate.

After computing the propensity scores, we compute the average export strategy of the firms in each treatment group and we compared it with the average export strategy of the matched firms in the control group. The firm's export strategy is represented by an indicator that takes the value of one if the firm reported that it will be looking for new markets to export in the next two years. Hence, for firms that already exported, looking for new markets implies expanding the export, looking for new markets is a synonymous for the decision to start exporting. Unfortunately, we do not know whether firms in fact do export in the future. To the extent that innovative firms may over-report their propensity to export, our results should be interpreted as an upper-bound on the true effect of innovation on export strategy. However, using information on export strategy rather than export revenues may reduce the problem of reverse causality that curses much of the literature on the link between innovation and export. When using information on export revenue, it is difficult to disentangle whether innovation was the cause or the result of exporting. Since in our case, exporting has not taken place yet, we can be sure that such reverse causal path is ruled out.

The descriptive statistics of the variable used in this analysis are reported in Table 2. As expected, both forms of innovation are more common among firms that plan on seeking new market. Also, technological innovation is more prevalent than non-technological innovation independently from whether they will seek new export markets or not. About half of the firms that reported no plan to seek new market abroad produced for local markets, while more than 70% of the firms that plan to seek new markets abroad are already operating in the international market. This suggests that firms that have already incurred in the fix cost of exporting will tend to keep on playing in the international arena. Finally, firms seeking new markets tend to produce more high quality products while firms that are not seeking new markets abroad tend to produce more medium to low quality products.

4 Propensity score analysis

A multinomial logit is used to compute the propensity score needed to match treated and control firms. The results of the multinomial logit are reported in Table 3. We observe that being an exporter does not affect the probability of adopting non-technological innovation alone, but it has a positive impact on the probability of developing a technological innovation (with or without non-technological innovation) as well. Firms that operate mainly on the local scale are less likely to incur any form of innovation. Firms that offer a medium-high quality product are more likely to innovate than firms producing a high quality product. However, this result may be driven by the small number of high quality good firms (less than 9% of the sample). Firms producing lower quality goods are less likely to innovate. Innovation can be a financially strenuous investment and firms that generate a larger turnover can benefit from having access to a larger cash flow. There is no evidence of any difference in the propensity to innovate between firms located in different geographical areas of the country. The age of the firm does not seem to affect the probability of carrying out either form of innovation, although older firms have a higher probability of carrying both forms of innovation. Finally, while there are differences in the propensity of a technological innovation across sector (the food and beverages being the most innovative sector), we do not observe the same differences for non-technological innovation.

Table 3 Multinomial logit (reference group: no innovation)

	Non-technical innovation		*Technical innovation*		*Non-technical and technical innovation*	
	Coef.	*Std. err.*	*Coef.*	*Std. err.*	*Coef.*	*Std. err.*
Type of market served:						
International	0.1919	0.2105	0.5063***	0.1275	0.9557***	0.1542
Local market	–0.6366***	0.1965	–0.3477***	0.1126	–0.5906***	0.1515
Quality:						
Medium high	0.6526**	0.3151	0.3292*	0.1967	0.3876*	0.2323
Medium	–0.5554*	0.3091	–0.6616***	0.1824	–0.9592***	0.2229
Medium low	–0.8325*	0.5002	–0.2938	0.2491	-0.6314*	0.3218
Low	–0.7077	0.6006	–1.1759***	0.3708	–1.0043**	0.4642
Revenues:						
From 300,000 to 1 million euros	0.4988**	0.2144	0.4113***	0.1193	0.6655***	0.1720
From 1 to 5 million euros	0.5132**	0.2536	0.2033	0.1456	0.9057***	0.1872
From 5 to 10 million euros	1.0176**	0.3954	0.7589***	0.2666	1.3159***	0.3076
> 10 million euros	1.3062***	0.3981	0.8198***	0.2826	1.8699***	0.2950
Location						
North	0.0806	0.2133	–0.0302	0.1268	0.0367	0.1708
Centre	–0.3826	0.2774	–0.1161	0.1558	0.0269	0.2034

Notes: Dummy variables for sector included but not reported.

Standard error robust to unobserved heteroskedasticity.

*** indicates 1% significance; ** indicates 5% significance level; * indicates 10% significance level.

Table 3 Multinomial logit (reference group: no innovation) (continued)

	Non-technical innovation		*Technical innovation*		*Non-technical and technical innovation*	
	Coef.	*Std. err.*	*Coef.*	*Std. err.*	*Coef.*	*Std. err.*
Year of establishment:						
Between 1961 and 1970	–0.1347	0.3872	–0.2181	0.2456	–0.4586*	0.2697
Between 1971 and 1980	0.0660	0.3346	–0.0210	0.2186	–0.4590*	0.2354
Between 1981 and 1990	–0.2179	0.3351	–0.1424	0.2128	–0.5953**	0.2330
Between 1991 and 2000	0.4788	0.3261	0.2704	0.2191	–0.0756	0.2367
After 2000	–0.6958	0.5511	–0.2925	0.2973	–0.8985**	0.4036
Constant	–1.5537***	0.5227	0.3285	0.3235	0.0275	0.3722

Notes: Dummy variables for sector included but not reported.
Standard error robust to unobserved heteroskedasticity.
*** indicates 1% significance; ** indicates 5% significance level; * indicates 10% significance level.

There are several algorithms that can be use to match a treated firm to a control *alter-ego*. We use a Kernel, 1-to-1, and radius matching algorithms. Moreover, we evaluate the radius matching algorithms using three levels of distance (0.1, 0.05, and 0.001). It is not clear in the literature which algorithm is to be preferred. However, we can compare the relative efficiency of each algorithm with respect to how well they balance the explanatory variables. The advantage of the PSM over OLS is that with PSM one can obtain a better balancing of the observable variables. Under a perfect match, the average value of each variable in the treatment group should be the same as in the control group. In Table 4, we report the median value of the absolute standardised bias for each variable used in the multinomial probit under each algorithm. The (absolute) bias after matching is defined as the (absolute value of the) difference of the sample means of each variables for the treated and the matched comparison sub-samples (Rosenbaum and Rubin, 1985). The absolute bias is then standardised by computing the bias as a percentage of the sample standard error. There is no rule about what should be the acceptable bias after matching. However, we observe a substantial reduction in the bias before and after any matching. On average, the bias drops by two thirds, with few cases of reduction larger than four fifths. We cannot identify an algorithm that always performs better than the others. The Kernel and the radius 0.05 produce similar results. The 1-to-1 matching seems to perform better on the pair technological and non-technological innovation versus no innovation, while the radius 0.01 matching seems to perform better on the pair technological innovation versus no innovation.

Table 4 Median absolute standardised bias

	Before matching	*Kernel matching*	*1-to-1 matching*	*Radius = 0.1 matching*	*Radius = 0.05 matching*	*Radius = 0.01 matching*
Technical innovation only	10.02	2.02	6.30	2.48	2.05	1.62
Non-technical innovation only	15.68	4.90	4.71	4.55	4.97	4.70
Technical and non-technical innovation	15.43	4.62	3.81	4.75	4.53	5.34

Table 5(a) Effect of the innovation on export

	Unconditional difference	*ATT-Kernel matching*	*ATT 1-to-1 matching*	*ATT-radius: 0.10 matching*	*ATT-radius: 0.05 matching*	*ATT-radius: 0.01 matching*
Technical innovation only	18.0%	8.1%	6.6%	8.8%	8.1%	7.8%
Non-technical innovation only	24.7%	12.5%	12.5%	13.4%	12.4%	12.7%
Technical and non-technical innovation	38.0%	18.7%	19.4%	19.8%	18.5%	19.7%

The estimation of the ATT of innovation using the matching estimator is reported in Table 5(a). As expected, the magnitudes of the ATT are much lower than the unconditional mean, and they are all significant at 1% confidence interval. A technological innovation increases the probability that a firm will plan to look for new markets abroad by 6.6 to 8.8 percentage points. The effect of a non-technological innovation is even larger, at 12.5 to 13.4 percentage points. Finally, the estimated effect of both forms of innovation is about 19 percentage points on average. This finding confirm our assumption that technological and non-technological innovations best exert their effect when combined together – i.e., those firms which combine product and process innovations with organisational and marketing changes will most likely plan to look for new markets abroad.

Next, we re-estimated our model on the sub-sample of firm that did not export at the time of the interview [see Table 5(b)]. For this sub-set of firms, looking for a market abroad signifies that the firm is planning to start exporting. Again, we found that non-technological innovations are more important for the decision to start exporting than technological innovation. In fact, a technological innovation alone increases the probability of starting to export between 6.1 and 7.3 percentage points. However, if a firm undertakes a non-technological innovation, the probability of starting to export jumps by twice as much. In latter cases, introducing a technological innovation does not improve the chances of starting to export. These findings are quite surprising and counterintuitive as they show that introducing non-technological innovations (alone) is by far the most effective strategy in order to enhance the probability of exporting in the future. A possible explanation of this finding is that switching from non-exporter to exporter requires profound changes in the management of a firm. These changes involve new management practices as well as new marketing strategies. In fact, as it was observed (Schienstock et al., 2009), firms are forced to initiate organisational restructuring programmes or to even introduce totally new organisational models if they want to be competitive on global markets.

Table 5(b) Effect of the innovation on export (sample: non-exporting firms)

	Unconditional difference	*ATT-Kernel*	*ATT 1-to-1*	*ATT-radius: 0.10*	*ATT-radius: 0.05*	*ATT-radius: 0.01*
Technical innovation only	8.8%	6.7%	6.6%	7.3%	6.9%	6.1%
Non-technical innovation only	19.5%	16.1%	12.4%	16.2%	15.6%	15.4%
Technical and non-technical innovation	19.3%	15.9%	12.7%	16.6%	15.9%	15.0%

5 Summary and implications

In this paper, we investigate the impact of innovating activities on future exporting strategies of small and medium enterprises. Specifically, we disentangle innovative activities into technological (product and process innovation) and non-technological (marketing and organisational changes) and tested the hypotheses that:

1 technological and non-technological innovations both enhance the probability of undertaking future exports decisions

2 these are complementary strategies, which are more effective when combined.

We conducted our investigations looking at Italian SMEs operating in manufacturing sector (reference year 2004). We observed a strong complementarity between these two classes of innovating activities as for the decision of penetrating new foreign markets. When restricting the analysis only to those firms that did not export at the time of the interview, we observe a growing relevance of non-technological innovations. The complementarity finding is in line with our expectations and confirms the general view that product and process innovations request organisational and marketing changes in order to effectively stimulate productivity and international competitiveness. Our second finding suggests even more the relevance of organisational restructuring programmes (which might evolve the introduction of totally new organisational models) and new marketing strategies when opening to international markets for the first time. This result implies that for new exporting firms, which lack the experience in marketing their products abroad, it is imperative to adapt marketing and organisational behaviours to cope with highly competitive and dynamic international markets.

Overall, emergences of our investigation are in line with extant literature [see, for instance, early studies like Wakelin (1998) or more recent works like Cassiman and Martinez-Ros (2007)] and suggest that innovation is a key asset for firms to compete in international markets. However, as our findings show, innovation must be understood as a multifaceted concept which often involves business and organisational changes, as well as technological advances. Consequently, innovation should be seen as a complex and composite process: it is not just the results of scientific work in a laboratory-like environment, but it might as well involve business model innovations, organisational innovations, marketing innovations and distribution channels innovations.

This study found that innovation plays a larger role than previously suggested. Previous studies have found that product innovation has only a small effect on the probability of exporting.[5] This should not be surprising since Iacovone and Javorcik (2010) show that firms enter foreign markets with products they already sell at home. Additionally, there is not agreement on whether or not process innovation fosters a firm's propensity to export with Becker and Egger (2009) concluding that there is not significant effect while both Hanley and Monreal-Pérez (2011) and Palangkaraya (2012) conclude that process innovation is most likely more important than product innovation. In line with these findings, this study found that technological innovation (i.e., the combined effect of product and process innovation) increases the propensity to export only between 6 and 8%. However, this study suggests that the total impact of innovation on export propensity is larger than previously estimated and that it operates mostly from non-technological innovation. This conclusion is consistent with the evidence that the prevalence of internet-based sales is higher among exporters than non-exporters. These findings have strong policy implications suggesting that traditional policy measure in support of innovation (such as R&D tax incentives) should be coupled with new soft instruments, which aim to stimulate companies' awareness of non-technological innovation.

6 Limitations and future research

Like any scientific work, this paper has some limitations that, far from being a source of discontent for the authors, provide a fertile ground for further research. We shall now try to identify these limitations, setting, at the same time, an agenda for future work.

First, it could be worth investigating complementarities disentangling technological and non-technological innovations into product and process innovations, and organisational and marketing innovations, respectively. This analysis would indeed allow getting a more detailed picture of the nexus existing among various types of innovations. However, it would require a different empirical methodology than the one presented in this paper as increasing the dimension of the innovation strategy space represent a real challenge for the PSM analysis.

A second limitation of our paper is that we did not take into account the targeted exporting market. In fact, firm's innovation decisions can have rather different effects depending on the exporting target market – e.g., a firm seeking to penetrate an emerging country like China will probably benefit differently from investments in technological innovation when compared to a firm seeking to penetrate the market of a rich country like Germany or France.

Finally, a further possible extension of this work would be to investigate the impact of product quality improvements as an alternative strategy for foreign market penetration. This issue is particularly relevant as most Italian firms are perceived and appreciated around the world specifically for the quality content of their goods. Most likely, quality improvements would show a strong complementarity with non-technological innovations, similarly to the one documented in this paper.

References

Aw, B.Y, Roberts, M.J. and Winston T. (2007) 'Export market participation, investments in R&D and worker training, and the evolution of firm productivity', *The World Economy*, Vol. 14, No. 1, pp.83–104.

Barua, A., Kriebel, C. and Mukhopadhyay, T. (1995) 'Information technology and business value: an analytic and empirical investigation', *Information Systems Research*, Vol. 6, No. 1, pp.3–23.

Becker, S.O. and Egger, P. (2009) 'Endogenous product versus process innovation and a firm's propensity to export', *Empirical Economics*, Vol. 44, No. 1, pp.329–354.

Bernard, A., Jonathan, E.J., Bradford, J. and Samuel, K. (2003) 'Plants and productivity in international trade', *American Economic Review*, Vol. 93, No. 4, pp.1268–1290.

Black, S. and Lynch, L.M. (2004). 'What's driving the new economy: the benefits of workplace innovation', *The Economic Journal*, February, Vol. 114, No. 493, pp.F97–F116.

Bloom, N., Sadun, R. and Van Reenen, J. (2012) 'Americans do IT better: US multinationals and the productivity miracle', *American Economic Review*, Vol. 102, No. 1, pp.167–201.

Bresnahan, T., Brynjolfsson, E. and Hitt, L. (2002) 'Information technology, workplace organization, and the demand for skilled labor: firm-level evidence', *Quarterly Journal of Economics*, Vol. 117, No. 1, pp.339–376.

Brynjolfsson, E. (1993) 'The productivity paradox of information technology', *Communications of the ACM*, Vol. 36, No. 12, pp.66–77.

Brynjolfsson, E. and Hitt, L. (2000) *Computing Productivity: Firm Level Evidence*, mimeo, The Wharton School, University of Pennsylvania.

Cassiman, B. and Martinez-Ros, E. (2007) *Product Innovation and Exports: Evidence from Spanish Manufacturing*, IESE Working paper, mimeo.

Cassiman, B., Golovko, E. and Martínez-Ros, E. (2010) 'Innovation, exports and productivity', *International Journal of Industrial Organization*, Vol. 28, No. 4, pp.372–376.

Dollar, D. (1986) 'Technological innovation, capital mobility, and the product cycle in north-south trade', *The American Economic Review*, Vol. 76, No. 1, pp.177–190.

Evenson, R.E. and Westphal, L.E. (1995) 'Technological change and technology strategy', in Behrman, J. and Srinivasan, T.N. (Eds.): *Handbook of Development Economics III A*, Elsevier Science, Amsterdam.

Girma, S., Görg, H. and Hanley, A. (2008) 'R&D and exporting: a comparison of British and Irish firms', *Review of World Economics*, Vol. 144, No. 4, pp.750–773.

Guo, S.Y. and Fraser, M.W. (2009) *Propensity Score Analysis: Statistical Methods and Applications*, Sage Publications, Thousand Oaks, California.

Hanley, A. and Monreal-Pérez, J. (2011) *Are Newly Exporting Firms More Innovative? Findings from Matched Spanish Innovators*, Kiel Working papers No. 1735.

Hansen, J.A. (1992) 'Innovation, firm size, and firm age', *Small Business Economics*, Vol. 4, No. 1, pp.37–44.

Heckman, J.J., Ichimura, H. and Todd, P.E. (1997) 'Matching as an econometric evaluation estimator: evidence from a job training programme', *Review of Economic Studies*, Vol. 64, No. 4, pp.605–654.

Iacovone, L. and Javorcik, B.S. (2010) 'Multi-product exporters: product churning, uncertainty and export discoveries', *Economic Journal*, Vol. 120, No. 544, pp.481–499.

Inklaar, R., Timmer, M.P. and van Ark, B. (2008) 'Market services productivity across Europe and the US', *Economic Policy*, Vol. 23, No. 53, pp.139–194.

Krugman, P. (1979) 'A model of innovation, technology transfer, and the world distribution of income', *Journal of Political Economy*, Vol. 87, No. 2, pp.253–266.

Lachenmaier, S. and Wößmann, L. (2006) 'Does innovation cause exports? Evidence from exogenous innovation impulses and obstacles using German micro data', *Oxford Economic Papers*, Vol. 582, No. 2, pp.317–350.

Lechner, M. (2001) 'Identification and estimation of causal effects of multiple treatments under the conditional independence assumption', in Lechner, M. and Pfeiffer, F. (Eds.): *Econometric Evaluation of Labor Market Policies*, Vol. 13, pp.43–58, ZEW Econ Stud.

Lin, L-H. and Lu, I-Y. (2006) 'Product quality as a determinant of product innovation: an empirical analysis of the global automotive industry', *Total Quality Management & Business Excellence*, Vol. 17, No. 2, pp.141–147.

Loveman, G.W. (1994) 'An Assessment of the productivity impact on information technologies', in T.J. Allen and M.S. Scott Morton (Eds.): *Information Technology and the Corporation of the 1990s: Research Studies*, MIT Press, Cambridge.

Melitz, M.J. (2003) 'The impact of trade on intra-industry reallocations and aggregate industry productivity', *Econometrica*, Vol. 71, No. 6, pp.1695–1625.

Morrison, C.J. and Berndt, E.R. (1990) *Assessing the Productivity of Information Technology Equipment in the U.S. Manufacturing Industries*, National Bureau of Economic Research Working Paper 3582.

Palangkaraya, A. (2012), *The Link Between Innovation and Export: Evidence from Australia's Small and Medium Enterprises*, ERIA Working papers No. 08.

Polder, M., van Leeuwen, G., Mohnen, P. and Wladimir, R. (2010) *Product, Process and Organizational Innovation: Drivers, Complementarity and Productivity Effects*, DRUID Working Paper No. 10-24.

Razzak, W, (2008) 'Self selection versus learning-by-exporting four Arab economies', *API/WPS 0804*.

Rosenbaum, P.R. and Rubin, D.B. (1985) 'Constructing a control group using multivariate matched sampling methods that incorporate the propensity score', *The American Statistician*, Vol. 39, No. 1, pp.33–38.

Schienstock, G., Rantanen, E. and Tyni, P. (2009) *Organizational Innovations and New Management Practices: Their Diffusion and Influence on Firms' Performance*, Working paper 1.2.d, University of Tampere, April, IAREG.

Schmidt, T. and Rammer, C. (2007) *Non-technological and Technological Innovation: Strange Bedfellows?*, DRUID Discussion paper No. 07-052.

Solow, R. (1987) 'We'd better watch out', *New York Times Book Review*, 12 July, p.36.

Vernon, R. (1966) 'International investment and international trade in the product cycle', *The Quarterly Journal of Economics*, Vol. 80, No. 2, pp.190–207.

Wagner, J. (2012) 'International trade and firm performance: a survey of empirical studies since 2006', *Review of World Economics*, Vol. 148, No. 2, pp.235–267.

Wakelin, K. (1998) 'Innovation and export behaviour at the firm level', *Research Policy*, Vol. 26, Nos. 7–8, pp.829–841.

World Bank (1993) *The East Asian Miracle: Economic Growth and Public Policy*, Oxford University Press, New York.

World Trade Organization (WTO) (2008) *World Trade Report 2008 – Trade in a Globalizing World*, WTO, New York.

Notes

1 Putting it differently, firms typically differ in terms of their productivity and they pay fixed entry costs to enter both the domestic and the foreign markets. Some firms find it profitable to sell only on the domestic market while the most productive select into exporting markets. This selection mechanism has been well documented empirically; see the recent and comprehensive survey by Wagner (2012).

2 As put by Cassiman and Martínez-Ros (2007, p.4) "there is not a causal theory about the relation between firm decisions and entry into the export market".

3 This is often referred to as the productivity (or Solow) paradox and was analysed in a paper by Brynjolfsson (1993), which noted the apparent contradiction between the remarkable advances in computer power and the relatively slow growth of productivity at the level of the whole economy, individual firms and many specific applications. This contradiction had been earlier stigmatised by Solow (1987) who stated: "You can see the computer age everywhere but in the productivity statistics".

4 This is due to the fact that firms operating in foreign markets gain access to technical expertise from international buyers and competitors (World Bank, 1993; Evenson and Westphal, 1995), which fuel their innovative performances.

5 For example, using a PSM Hanley and Monreal-Pérez (2011) found that at best product innovation leads to an increase in the probability of becoming a new exporter by 4%. Palangkaraya (2012) found only a weak evidence of any relationship between product innovation and export strategy.