Dissecting the impact of innovation on exporting in Turkey

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Abstract

Making use of an original firm level dataset, we explore the causal impact of innovation on the manufacturing firm export activity in Turkey. We model process and product innovation as separately - through cost savings and product quality improvements, respectively - affecting the firm profitability and, consequently, the firm export propensity. This modeling choice highlights heterogeneous effects across high and low income destination markets. In a Multiple Propensity Score Matching framework, we, then, test the impact of each innovation activity and of their joint adoption. We find that only the latter fosters the first time entry into exporting, when the destination market is high income. Nevertheless, innovation positively affects the firm export propensity. New product introduction is more rewarding than process innovation, especially for exporting to low income economies. Process innovation, though, strengthens the positive role of product innovation for exporting to more advanced markets.

JEL: *O31, D22, F10, F14*

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1. Introduction and background

The mechanisms behind firm competitiveness and international success have always drawn the attention of a large part of economics and business literature. In this respect, firm innovation activity may constitute one of the main channels fueling the firm entry in foreign markets. On one hand, the development of new products, better tailored for the customers' preferences in destination market, may ease the firm access to such market. On the other hand, the introduction of new production processes may importantly reduce the operational costs and improve the firm ability to face export sunk costs and cross the national borders.

Understanding the returns to innovation in terms of the firm activity in foreign markets turns to be particularly relevant from an emerging economy perspective. Innovation, indeed, is particularly costly for developing countries, due to their limited human capital and technology endowment. However, for these economies the export market represents an unprecedented opportunity, as it favours the exploitation of scale economies, technology transfers and new learning possibilities. As a consequence, it is fundamental to ascertain whether the innovative effort undertaken by firms is fruitful in promoting their presence abroad. We, then, contribute to this topic by dissecting the role of product and process innovation and of their joint adoption on the manufacturing firm export propensity in Turkey.

Previous evidence is mainly focused on developed economies and has in general shown a positive causal impact of innovation on exporting.[1] Before Melitz's (2003) contribution on firm heterogeneity, empirical literature had shown a positive direct relationship between product innovation and exporting (Kumar and Siddharthan, 1994; Wakelin, 1998; Sterlacchini, 1999, 2001; Basile, 2001; Roper and Love, 2002). Recently, instead, the widespread evidence on the existence of important productivity differences between exporters and non exporters in the period preceding the foreign market entry (Wagner, 2007) has stimulated a growing stream of literature aimed at analysing the sources of such differences. Some papers, then, are rethinking the relationship between the firm innovation effort and its export performance. In this line, Cassiman and Golovko (2011) for Spain have tested and verified the hypothesis that product innovation has both a direct and mediate - through productivity - effect on exporting. However, other evidence on the same country shows that productivity still matters for non-innovators, so that other channels affect productivity out of product innovation (Cassiman et al., 2010). Caldera (2010) reverses this view and, building on Bustos (2011), models more productive firms as self selecting into innovation and innovators as being more likely to become exporters, due to the marginal cost reduction effect of innovation. Her empirical findings confirm once again the important role of innovation for the Spanish firm export probability. However, the heterogeneity across product and process innovation strategies has been rather neglected in the literature. The only noticeable exception is represented by Becker

[1] Van Beveren and Vandenbussche (2010) constitute an exception as, on Belgian data, they find that innovation is actually an anticipated effect of exporting.

and Egger (2009), who, on the German data from business and innovation surveys, show that such a distinction is rather important as they find the dominant importance of product with respect to process innovation, which only matters when adopted in conjunction of product innovation.

Within this framework, our theoretical view of the nexus between innovation and exporting is close to Caldera (2010), as we model more productive firms self-selecting into innovation and, in turn, innovation enhancing the export probability. Our empirical approach, instead, is similar to the one undertaken by Becker and Egger (2009): within a Multiple Propensity Score Matching (MPSM) framework, we treat process and product innovation as two different strategies that, when adopted alone or in conjunction, may have different effects on the firm export probability. However, our analysis presents several original contributions. First, building on the evidence on heterogeneous determinants and impacts of the two innovation strategies, differently from Caldera (2010), we model product and process innovation as affecting the firm profitability through two different channels. Whereas product innovation positively affects the firm product quality, process innovation negatively affects its marginal costs. Our modeling strategy permits to highlight the reason why the two innovation activities are often undertaken together and constitutes the theoretical motivation for our empirical approach. Second, our focus is on an emergent country. It is interesting to investigate whether the importance of firm innovative efforts for the success in the export market is different in this context, compared to a developed country one. Whereas the notion of process innovation is rather similar in the two settings, a large fraction of product innovations in a developing economy consist of already existing products in the market that are new only to the firm. In this respect, it is fundamental to assess the relevance of such type of innovations in terms of returns from the export activity and to compare the findings to the existing evidence on developed economies. Third, we analyse the role of innovation for the first time entry and for the survival in the foreign market. Fourth, differently from Becker and Egger (2009), we split the firm export status, i.e. our outcome of interest, according to the income level of the destination market in order to test whether entry in heterogeneous markets with different preferences for quality (Hallak, 2006, 2010) and different average production costs is related to heterogeneity in the innovation strategy. Fifth, from the bulk of firm exports we neglect the so-called Carry-Along Trade (CAT) activity and focus on the manufacturing firm exports of own products (Bernard et al., 2012). This choice follows the need to isolate the innovation effect on the firm's ability to sell its own products abroad, as innovation deeply affects the firm own production technology. Finally, to the best of our knowledge, it is the first time that Turkish data are used to test the causal impact of innovation on exporting. In particular, our sample is obtained by matching several data sources and constitutes an original dataset never used before for the investigation of this topic for Turkey.

The work is structured as follows: the next section presents our theoretical framework; section 3 introduces the data sources and some evidence on product and process innovation for Turkish manufacturing; section 4 presents the empirical strategy; section 5 shows the main results from our analysis and section 6 concludes.

2. Theoretical framework

To model the impact of innovation on the export propensity of Turkish firms we rely on a simple theoretical framework which adapts the one in Bustos (2011), so as extended by Caldera (2010). However, we depart from them in a number of ways in modeling both the demand and supply. Firstly, we separately model process and product innovation and their joint adoption. Secondly, while Bustos (2011) models the endogenous firm choice of technology that follows to trade liberalisation, we aim at modeling the impact of adopting an innovation on the firm export propensity. In this respect, here we offer a partial equilibrium approach, so we will abstract from dealing with the industry dynamics and we will assume the industry characteristics as fixed and unchanged with respect to the choice of the single firm. As in Caldera (2010), we start showing that more productive firms engage in innovation and, from this, we demonstrate that innovators are more likely to export. However, our main contribution relies in the different channels we exploit for product and process innovation which allow for a richer pattern of possibilities in the relationship between innovation and exporting. In a standard monopolistic competition framework (Dixit and Stiglitz, 1977; Melitz, 2003), our main novelty is to model product and process innovation as two separate strategies which may also be adopted in conjunction. This, indeed, is also the starting point of our empirical strategy that motivates the adoption of a MPSM framework. In our view, both product and process innovation positively affect variable profits in face of an additional fixed cost to sustain for the adoption of the innovation strategy. However, whereas process innovation positively affects variable profits through the reduction of the marginal production cost, the introduction of a new product allows the firm to switch to the production of a higher quality variety and to earn higher revenues and variable profits.[2] This framework shows, in line with Caldera (2010), that larger and more productive firms are more likely to innovate and that innovators are more likely to export. Also, from the distinction between the two different channels through which innovation affects profits, we will show that among innovators, those firms undertaking both product and process innovators are more likely to export, compared to *one-way* innovators.

2.1. Demand

To model the impact of innovation on the firm export behaviour, we take as hypothesis that consumer's preferences can be represented by a CES utility function over different varieties ω of good X which, as in the quality ladder model by Grossman and Helpman (1991, 1993) differ in their quality content q. The representative consumer has income M and, given prices maximises utility

[2]An extensive literature deals with the relationship between product quality and exports at the firm level. As an example Verhoogen (2008) models the firm quality upgrading choice in a framework with quality differentiation in production and heterogenous preferences for quality in the North and the South. More recently, Crinò and Epifani (2012) analyse the interplay between cross-firm heterogeneity in product quality and cross-country heterogeneity in quality consumption. In both settings the quality choice is endogenous and depends on export market characteristics and shocks (e.g. a devaluation). Here our aim is not to model the choice of quality, but to show how higher product quality can enhance the export probability.

$$U = \left[\int_{\omega \in \Omega} q(\omega) x(\omega)^{\rho} d\omega \right]^{\frac{1}{\rho}} \tag{1}$$

From the equation, the elasticity of substitution among varieties is $\sigma = \frac{1}{(1-\rho)}$ and the demand for the generic variety ω_j is:

$$x(\omega_j) = \frac{P_{\omega_j}^{-\sigma}}{P^{1-\sigma}} M \tag{2}$$

with $P_{\omega_j} = \frac{\tilde{p}_{\omega_j}}{q_{\omega_j}}$ denoting the quality adjusted price of variety ω_j, $\tilde{p}$ denoting the unadjusted price and P denoting the aggregate price index.

2.2. Supply

To describe the supply side of this simple theoretical sketch, we follow Bustos (2011) and the adaptation provided by Caldera (2010) to model the impact of innovation on the firm export status. However, we depart from them in that we separately model process and product innovation and their joint adoption. As in Melitz (2003), we assume that firms differ in their productivity level ϕ_i , whereas they share the same unit variable cost labeled as c. The manufacturing industry operates in monopolistic competition so that for all varieties the pricing strategy can be resumed by means of a markup $\frac{\sigma}{\sigma-1}$ over the marginal cost, which, then, is assumed to be $\frac{c}{\phi_i}$.

To enter the manufacturing industry a firm pays a fixed entry cost and draws its productivity from a cumulative distribution function. After observing its productivity, a firm decides whether to exit or to stay and produce. In the latter case, according to its productivity level the firm may:

- Produce by means of the standard technology, which requires a fixed production cost, f, and grants revenues

$$r_0(\phi) = [\frac{\sigma - 1}{\sigma}\frac{\phi q(\omega)}{c}P]^{\sigma-1}M \tag{3}$$

and profits

$$\Pi_0(\phi) = \frac{r_0(\phi)}{\sigma} - f \tag{4}$$

- Introduce a process innovation, which requires an additional fixed cost f_{Pc}, reduces the variable unit cost to $c_{Pc} < c$ and grants revenues

$$r_{Pc}(\phi) = [\frac{\sigma - 1}{\sigma}\frac{\phi q(\omega)}{c_{Pc}}P]^{\sigma-1}M \tag{5}$$

and profits

$$\Pi_{Pc} = \frac{r_{Pc}(\phi)}{\sigma} - f - f_{Pc} \tag{6}$$

- Introduce a product innovation, thus switching to the production of a better quality variety, which requires an additional fixed cost f_{Pd} and grants revenues

$$r_{Pd}(\phi) = [\frac{\sigma - 1}{\sigma}\frac{\phi q_{Pd}(\omega)}{c}P]^{\sigma-1}M \; with \; q_{Pd}(\omega) > q(\omega) \tag{7}$$

and profits

$$\Pi_{Pd}(\phi) = \frac{r_{Pd}(\phi)}{\sigma} - f - f_{Pd} \tag{8}$$

- Introduce both a process and product innovation which, under the simplifying assumption that the new variable cost is the same as under process innovation only, grants revenues

$$r_{PdPc}(\phi) = [\frac{\sigma-1}{\sigma}\frac{\phi q_{Pd}(\omega)}{c_{Pc}}P]^{\sigma-1}M \; with \; q_{Pd}(\omega) > q(\omega) \tag{9}$$

and profits

$$\Pi_{PdPc}(\phi) = \frac{r_{PdPc}(\phi)}{\sigma} - f - \lambda(f_{Pd} + f_{Pc}) \; with \; 0 < \lambda \leq 1 \tag{10}$$

The assumption on λ derives from the possible existence of a strong complementarity between process and product innovation (Van Beveren and Vandenbussche, 2010). The majority of innovators (61% in our data) are actually involved in both activities.

The innovation decision -. The firm, then, decides to introduce a process innovation if

$$\left(\frac{1}{c_{Pc}^{\sigma-1}} - \frac{1}{c^{\sigma-1}}\right)[\frac{\sigma-1}{\sigma}\phi q(\omega)P]^{\sigma-1}M > f_{Pc} \tag{11}$$

a product innovation if

$$\left[q_{Pd}(\omega)^{\sigma-1} - q(\omega)^{\sigma-1}\right]\left(\frac{\sigma-1}{\sigma}\frac{\phi}{c}P\right)^{\sigma-1} M > f_{Pd} \tag{12}$$

and both a product and a process innovation if

$$\left(\frac{q_{Pd}(\omega)}{c_{Pc}}\right)^{\sigma-1} - \left(\frac{q(\omega)}{c}\right)^{\sigma-1} [\frac{\sigma-1}{\sigma}\phi P]^{\sigma-1} M > \lambda(f_{Pd} + f_{Pc}) \tag{13}$$

Then, the probability to engage in product innovation is driven by quality upgrading whereas the probability to engage in process innovation is driven by cost saving. In any case, a higher productivity level delivers a higher probability to engage in innovation (Caldera, 2010). Given all this framework, an interesting point, that follows from our assumption on the different operational channels of process and product innovation, is that, under the hypothesis of strong complementarity between the two types of innovation (λ sufficiently less than 1), it is in general more likely that firms undertake them both as the lower marginal cost and the higher quality deliver variable profits higher than in the single innovation strategy case, whereas the fixed cost of innovation is less than the summation of the two innovation fixed costs.[3]

[3]Taking the difference between equation 10 and 6we get:

$$\pi_{PdPc} - \pi_{Pc} = \frac{r_{PdPc}(\phi)}{\sigma} - \frac{r_{Pc}(\phi)}{\sigma} + f_{Pc}(1-\lambda) - \lambda f_{Pd}$$

while, taking the difference between 10 and 8 we obtain:

$$\pi_{PdPc} - \pi_{Pd} = \frac{r_{PdPc}(\phi)}{\sigma} - \frac{r_{Pd}(\phi)}{\sigma} + f_{Pd}(1-\lambda) - \lambda f_{Pc}$$

These expressions hint at the introduction of one innovation strategy as favouring the adoption of the other one, compared to one-way innovators.

The export decision -. Now, after the description of the innovation choice, we may turn to the export decision. We make the usual assumption that entry in the export market is costly due to the presence of a fixed export entry cost, f_{exp}[4], and a variable iceberg transport cost $\tau > 1$. The decision to export or not will be made comparing profits after the entry to profits in the domestic market and a firm will export if $\pi^* + \pi > \pi$ where superscript * indicates the variable corresponding to the foreign market. A non-innovator will export if

$$\frac{\tau^{(1-\sigma^*)}}{\sigma^*} r_0^*(\phi) > f_{exp} \tag{14}$$

Firms introducing process innovation will export if

$$\frac{\tau^{(1-\sigma^*)}}{\sigma^*} r_{Pc}^*(\phi) > f_{exp} \tag{15}$$

Firms introducing product innovation will export if

$$\frac{\tau^{(1-\sigma^*)}}{\sigma^*} r_{Pd}^*(\phi) > f_{exp} \tag{16}$$

Finally, firms introducing process and product innovation will export if

$$\frac{\tau^{(1-\sigma^*)}}{\sigma^*} r_{PdPc}^*(\phi) > f_{exp} \tag{17}$$

[4]This cost is usually higher for the first time entry, as sunk costs need to be born when entering foreign markets for the first time. Nevertheless, if entry costs depend on the firm degree of market penetration it may well be the case that they increase in subsequent years, due to the firm growing cost of maintaining and expanding market shares in foreign markets (Crinò and Epifani, 2012). If this is the case, innovation might turn more relevant to survive than to enter an export market for the first time.

with r^* representing revenues in the foreign market which depend on foreign income M^* and on the foreign aggregate price index P^*. $\sigma^* \geq \sigma$, instead, represents the demand elasticity in the foreign market which is assumed to be higher under the hypothesis of tougher competition abroad than in the domestic market (Caldera, 2010). Comparing innovators and non-innovators, it is straightforward to see that innovators are more likely to export, and it is more so for "two-way" innovators. As a matter of fact, the differences between equations 17 and 16 and between equations 17 and the 15 rest on the difference of variable profits under alternative innovation strategies and they always turns to be greater than zero. On the contrary it is not easy to say whether only product or only process innovation prevail when they are adopted in isolation, even if they both enhance the firm export probability. The difference between equations 16 and 15 is lower, equal or higher than zero when $\frac{q_{Pd}(\phi)}{q(\phi)}$ is lower, equal or higher than $\frac{c}{c_{pc}}$. In other words, when the relative quality improvement is higher than the cost advantage from innovation, the firm export probability will be enhanced more by product than by process innovation. Furthermore, if we assume proportionality between home and foreign markets in relative quality and marginal cost and define average foreign quality as $q^* = \frac{q(\phi)}{\delta}$ and foreign marginal cost as $c^* = \delta c$, with $\delta > 0$, we have that product innovation is superior to process innovation when

$$\frac{q_{Pd}(\phi)}{q^*} - \frac{c^*}{c_{Pc}} > 0 \tag{18}$$

and this difference increases as either q^* or c^* decline. This means that product innovation is more rewarding than process innovation when exporting to low income partners which display a lower average quality and a lower production marginal cost. On the contrary, it is relatively less rewarding when exporting to high income destination. However, it is worth to mention that entry costs may differ according to the export location and in particular the the destination market income level (Arkolakis, 2010; Crinò and Epifani, 2012). In this respect, high income markets are tougher to penetrate due to the higher average productivity of firms, their higher thickness and the higher preference for quality of their consumers. So innovation may be rather determinant to break into these markets, while it may not be necessary to access low income destinations.

Resting on this theoretical model, we aim at testing the following hypothesis:

Hypothesis 1: Innovation positively affects the firm export propensity;

Hypothesis 2: Returns from each innovation activity may be heterogeneous, with *two-way* innovation dominating the *single* innovation strategies;

Hypothesis 3: Returns from each innovation activity may be heterogeneous according to the destination market income level: we expect the contribution of product innovation to be more relevant for exporting to low income destination and the contribution of process innovation to be more relevant for exporting to high income destinations.

3. The data

3.1. The Data Sources

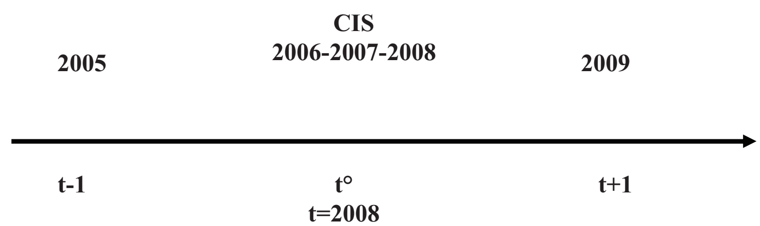
As mentioned in the introduction, the data for this study are provided by TurkStat and come from the merge of several sources which are listed and described in the following.

The Community Innovation Survey (CIS) 2008 -. We use the 2008 wave[5] of the Community Innovation Survey (CIS) which delivers information about the firm innovation activity and allows for the distinction between process and product innovation. These variables, that will represent the treatments in our empirical framework, refer to a three-year period: the survey asks firms about the introduction of new processes and new products during the period 2006 to 2008. Consequently, when a firm declares to have innovated in that period we cannot identify whether the firm was engaged in a persistent activity or whether the firm only innovated in one year and, if this is the case, we are not able to identify it.[6] Due to this data structure, we are forced to consider the innovation action occurring in the 2006-2008 time span as occurring in a unique period. Thus, in the rest of the paper we label t^o the treatment period which corresponds to the time frame starting in 2006 and ending in 2008 and the reference year for this period

[5]The 2006 wave was also available, but few observations were left after the matching with the other data sources. For this reason we preferred to focus on the 2008 wave, keeping the 2006 one only for a robustness check on the pooled 2006 and 2008 waves.

[6]It is, also, worth to notice that we have no information about the firm innovation in the period preceding the survey. As a consequence, due to the lack of innovation data for a long time-span, our treatments, as usually in most of the mentioned literature, capture the engagement in innovative activity, but not the start of this activity.

Figure 1: Time Line



is the last year in the span, i.e. $t = 2008$. Figure 1 shows our sample time line. The data includes all firms with more than 250 employees and a sample for firms between 10 and 250 employees and cover both service and manufacturing firms. However, our focus is on manufacturing firms only.

The Structural Business Statistics (SBS) -. The Annual Industry and Service Statistics collect information on firm revenues, input costs, employment, investment activity and the primary 4 digit NACE (rev 1.1) sector of activity over the period 2003-2008. These data cover the whole population of firms with more than 20 employees and a representative sample of firms with less than 20 employees. The economic activities that are included in the survey are the ones in the NACE sections from C to K, and from M to O.

The Foreign Trade Statistics (FTS) -. Foreign trade flows at firm level are sourced from customs declarations and are available for the 2002-2009 time span. The import and export flows are collected for the universe of importers and exporters of goods at 12-digit Gümrük Tarife Istatistik Pozisyonu (GTIP) classification: the first 8 digits correspond to Combined Nomenclature (CN) classification, and the last 4 digits are national. Furthermore, the information on the origin/destination countries of trade flows is available. It is worth to notice that the recorded flows concern both all trading and produced goods a manufacturing firm sells abroad. For this reason, we exploited firm level production data, described just below, in order to discern produced exports from the bulk of the firm exports. We made use of a correspondence between the codes of produced goods and the codes of trade flows at a high level of disaggregation, thus connecting 10 digit PRODTR production codes with 12 digit GTIP trade codes.[7] Since the matching between production and trade data may be problematic due to some potential mistakes in the attribution of the good codes to each trade and production flow, we have also adopted a more aggregated correspondence table.[8] Some recent firm level evidence for other countries seems to confirm that a large share of exports, also for manufacturing firms, concerns goods that are simply traded and not produced (Bernard et al., 2011, 2012). The distinction between own produced goods and the traded ones is important from a conceptual point of view in this paper since

[7]We have harmonised the codes of trade flows across years, since the trade classification is updated every year. On the contrary, production data were recorded according to a uniform classification over our sample of analysis.

[8]More details about the harmonisation procedure of product classification and the matching between trade and production data is available in Lo Turco and Maggioni (2012).

we can expect innovation to have a direct impact, if significant, on the ability of firms to penetrate foreign markets with their own products. Both product and process innovation affect the firm production activity: the former drives the firm to introduce improved goods, or different varieties that foreign consumers may appreciate and would like to purchase, while the latter may help the firm to reduce production costs. Thus, both types of innovation may stimulate and ease the export of produced goods. There is no a direct link, instead, between the firm innovative efforts and the selling activity of traded goods. As a consequence, our main focus will be on the export activity of firm own products.

The Annual Industrial Product Statistics (AIPS) -. The TurkStat Annual Industrial Product Statistics contain information on the type and number of produced goods, their volume and value of production together with the total quantity and value of total sales from goods produced within the reference year or preceding years. Product data are available for the years 2005-2009 and are collected at 10-digit PRODTR level[9], a national product classification with the first 8 digits corresponding to PRODCOM classification. The production data are available for firms with more than 20 persons employed and whose primary or secondary activity is in either C section (Mining & Quarrying) or D section (Manufacturing) of NACE Rev 1.1.

[9]The PRODTR classification is the 2006 one, thus it is homogeneous across years and does not require any harmonisation procedure.

3.2. The sample and the descriptive evidence

The 2008 wave of the CIS is composed of 2,822 manufacturing firms.[10] When we keep in the dataset only those firms for which we have information from SBS and AIPS dataset we are left with 1,569 firms that represent our final sample. This sample is biased towards the medium and large firms. The median size - in terms of number of employees - is 159 employees. In our view this bias does not represent a serious concern since only a low number of small firms are engaged in innovation and export activity, that are the two phenomena investigated in this paper. However, it would be interesting to have the possibility to disclose the effects of innovative efforts engaged by very small firms, when suitable data will be available.

Table 1 gives an overview of the diffusion of innovation practices across Turkish manufacturing firms. As above, in the rest of the paper we will label *Pd* the product innovation and *Pc* the process one. About 40% of firms in our sample is engaged in some innovative activities, and the largest part of them is introducing both new/improved products and new production processes.

Table 1: Share of Innovators by Type (%)- 2008 CIS wave

Type of Innovators	**Pd**	**Pc**	**Both Pd & Pd**	**Only Pd**	**Only Pc**
Share (%)	39.32	36.84	28.87	10.45	7.97

Source: Own calculations on the sample obtained by merging Turkstat CIS, SBS, FTS and AIPS. *Pd* and *Pc* denote the product innovators and process innovators, respectively. The shares refer to 2006-2008 three-year period.

[10]The total number of firms, covering both service and manufacturing sectors, is 4,891.

When we cross the information about the innovation activities with the firm export involvement in Table 2 some interesting insights emerge. It is clear that firms engaged in some kind of innovative efforts are generally more likely to penetrate foreign markets with their own products. There is not a great difference in the advantage that product innovators and process innovators enjoy with respect to the population of non process innovators and non product innovators respectively. However, when we classify firms into four mutually exclusive groups - including both product&process innovators, only process innovators, only product innovators and non-innovators - it follows that the introduction of new products is a more rewarding strategy in terms of firm success in the international arena. The production of improved and/or new goods is related to a higher probability to be an exporter. In opposite, process innovators only are engaged in international markets slightly less than non-innovators and the renewal of production processes seems to play a role just when it is combined with a new product introduction.

Finally, turning the attention to destination countries, the Table shows that innovators are more likely than non-innovators to export to low income destinations and that although product innovators are more likely to export both to high and low income countries[11], they are slightly more likely to export to low income countries. In addition, whereas pure process innovators are more involved than non-innovators in exporting to low income countries, they are less involved in exporting to high income economies. Nevertheless, when process innovation is

[11]The definition of the two groups follows the World Bank country classification.

adopted in conjunction with product innovation the firm export probability is enhanced, regardless of the destination area income level. The overall evidence from Table 2 points at some heterogeneity across the innovation strategies and destination markets that should be rigorously accounted for in empirical work. Resting on the above theoretical framework and on this evidence, the next sections are devoted to the empirical dissection of the impact of product, process and product&process innovation on the firm export propensity.

Table 2: Firm Export Involvement by Innovation Activity

	Exp	**Exp**$_{Hic}$	**Exp**$_{Lic}$
All Sample	48.37	39.32	39.13
Non-Pc	45.41	36.23	35.22
Pc	53.46	44.64	45.85
Non-Pd	43.59	34.14	33.40
Pd	55.75	47.33	47.97
Non-Innovator	43.77	34.22	32.89
Only Pc	42.40	33.60	36.80
Only Pd	53.66	46.34	46.95
Both Pc & Pd	56.51	47.68	48.34

Source: Own calculations on the sample obtained by merging Turkstat CIS, SBS, FTS and AIPS.
Pd and *Pc* denote the product innovators and process innovators, respectively.
Exp captures the general firm export status, while Exp_{Hic} and Exp_{Lic} indicate the export activity to High and Low Income countries, respectively.

4. Empirical strategy

In order to shed light on the causal effect of innovation on export activity, we make use of the propensity score matching in a multiple treatment framework (Lechner, 2001, 2002).[12] Building on our theoretical background, we focus on both product and process innovation, that, as highlighted in section 2, may differently affect the firm operations, and we consider a set of mutual exclusive treatments the firm may undergo: (0,0) is the no treatment case, no innovation activity; (*Pd*,0) represents the product innovation only; (0,*Pc*) represents the process innovation only; finally, (*Pd*,*Pc*) represents the case of both product and process innovation.

Our aim is to assess the Average Treatment effects on the Treated (ATT) for each treatment *a*, that is the outcome a firm in the different state *b* would experience if it underwent the treatment *a*. However, each participant receives just one treatment and the remaining ones are potential counterfactuals. Then, the comparison of each state S with the other ones leads us to a full set of ATT effects

$$\gamma^{a,b} = E(Y^a_{post}|S = a) - E(Y^b_{post}|S = a) \tag{19}$$

that denote the expected (average) effect on outcome Y of treatment *a*, in the post-treatment period, relative to treatment *b* for a participant drawn randomly

[12] We have also applied simple propensity score matching retrieving the effects of innovation on firm export activity when process and product innovation are treated as two separate, independent and different treatments. The relative results are available from the authors.

from the firms undergoing the treatment *a*. As $E(Y^b_{post}|S = a)$ is not observable, it is proxied by the outcome of the units that actually undergo the treatment of comparison *b*, $E(Y^b_{post}|S = b)$.

In particular, we can obtain different ATT effects, for each variable of interest, for each of the following pairs:

- $(0, Pc)/(0, 0)$ - Process Innovators Only/Non Innovators;
- $(Pd, 0)/(0, 0)$ - Product Innovators Only/Non Innovators;
- $(Pd, Pc)/(0, 0)$ - Product and Process Innovators/Non Innovators;
- $(Pd, Pc)/(0, Pc)$ - Product and Process Innovators/Process Innovators Only;
- $(Pd, Pc)/(Pd, 0)$ - Product and Process Innovators/Product Innovators Only;
- $(Pd, 0)/(0, Pc)$ - Product Innovators Only/Process Innovators Only;
- $(0, Pc)/(Pd, 0)$ - Process Innovators Only/Product Innovators Only;

where the first group of firms represents the group of treated, while the second group of firms builds up the control group.

In order to find the control units to be matched with the treated units we estimate a multinomial logit model from which we recover the propensity scores for each of the four states above defined. The multinomial logit dependent variable is the probability to introduce a process/product/process&product innovation in t, that is in the period 2006-2008, and we include the value of the following variables retrieved by the FTS and the SBS in $t - 1$, i.e. in 2005:

- the log of the number of employees, l;
- the log of labour productivity (value added per employee), lp[13];
- the log of the unit wage (total wage bill divided by the number of employees), w;
- the share of R&D workers in total firm employment, $EmpRD$;
- dummy variables for the previous experience in the Low and High income import, Imp_{Lic} and Imp_{Hic}, and export markets, Exp_{Lic} and Exp_{Hic};
- a dummy variable for multi-plant firms, $multi$;
- a dummy variable for firms subcontracting part of their production, $outs$;
- a dummy variable for the status of subcontractor, $subcont$.

Finally, we include two digit Nace Rev. 1.1 sector fixed effects. Table A.1 of the Appendix displays the results of the logit for the selection of the control units. It is worth to highlight that, apart from firm size that positively affects the probability to innovate, regardless of the type of innovation activity, from the Table it emerges that the drivers of process and product innovations are rather different. On the one hand, the former is positively related to firm wage and negatively related to firm import activity from low income economies. The cost saving nature of such innovations suggests that importing inputs from low income economies

[13]The lack of data about the firm tangible assets prevents us from computing a Total Factor Productivity measure.

reduces the need to introduce cost saving process innovations, so as an increase in the firm average wage may push the firm to adopt cost saving process innovations to compensate the higher unit labour cost. On the other hand, the probability to introduce a new product is positively and significantly related to the share of R&D workers in the firm. This is rather consistent with the idea of product innovation being related to some new invention which stems from the firm research effort. The firm size and share of R&D workers are also positively and significantly related to the probability to introduce product and process innovation at the same time. Nevertheless, this complex activity appears to be also driven by the firm productivity and the firm status as an outsourcer. In this respect, process innovation could be essentially directed to the introduction of the new product: the firm outsources the less R&D intensive production processes, while retaining the more knowledge intensive phases of production which are directed to the new product invention. Finally, as far as productivity is concerned, strangely enough it only affects the joint adoption of product and process innovation. This result however might depend on the use of labour productivity which is highly related to the firm capital labour ratio and could not properly proxy for the firm Total Factor Productivity.[14]

In conclusion, the multinomial logit results confirm that the three strategies are heterogeneous and highlight the need to tackle them in isolation the one from each other. Our MPSM empirical framework, then, can be considered particu-

[14]Unfortunately the lack of any information on the firm capital stock together with the short time span at our disposal which is not suitable for the use of the perpetual inventory method, prevented us from calculating such a productivity measure.

larly suitable for this task.

Making use of the propensity scores resulting from the multinomial logit estimates, we apply the Kernel matching and in Table A.2 in the Appendix we show some tests revealing the quality of the matching. The latter significantly reduces the median standardized bias, that is the distance in marginal distributions of the covariates between treated and control units. Also, only a low number of treated firms lay out of the common support. Finally, Figure A.1 shows that the distribution of the propensity score for matched controls overlaps the one of treated firms after the matching procedure for all the treatments. Even if the goodness of our strategy is slightly worse when the control group is composed of process innovators only, (0,Pc), or product innovators only, (Pd,0), because of the small size of these two groups, the evidence confirms the general validity of the matching. One of the advantages of kernel matching when compared to other matching algorithms, especially Nearest Neighbour matching, is the exploitation of as much information as possible from the control group and this is important in our context due to the general low number of firms in all the four groups described above.[15] The Radius Matching is another possible alternative that we present in our robustness checks.

[15]As a matter of fact, when we have tried to apply the Nearest Neighbour matching the tests, we just presented for the kernel matching, for the quality of matching failed to confirm the validity of our procedure.

5. Results

Table 3 shows the ATT effects for our outcomes of interest: the firm first time export entry, Exp_{Start}, and the export status, Exp, at time *t* and *t+1*, that is in 2008 and 2009. We define an export starter a firm that exports in t $(t+1)$ and did not export in *t-1*, i.e. a firm that exports in 2008(2009) and was not exporting in 2005. We define an exporter any exporting firm, regardless of the previous export activity. It is worth to remind here that the latter is properly accounted for in the matching procedure, when we consider the firm previous export activity in high and low income economies in the logit model for the innovation treatment. This trick avoids any potential innovation impact on exporting to be driven by previous activity in international markets. While the export entry allows us to capture the role of innovation in the overcoming of the national barriers and penetrate foreign markets for the first time, the export status may inform us about the importance of the firm innovative efforts in preserving their position on the foreign market.

In the Table, analytic, $A.s.e.$, and bootstrapped, $B.s.e.$, standard errors are shown below the ATT estimates (Lechner, 2001; Caliendo and Kopeinig, 2008). From the latter it emerges that process innovation alone does not seem to importantly stimulate the firm export activity, with a relevant role on the export status only at time *t+1*. Product innovation, instead, allows the firm to preserve its competitiveness and market shares in foreign countries. Furthermore, the joint involvement in product and process innovation directly affects the export status, but no impact is disclosed for the firm ability to cross the borders and enter foreign markets for the first time. From these results, we can infer that innovation may help the firm to stay, preserve and strengthen its position in the international arena, but it is not the main determinant for the export market first time entry.[16] In general, overall returns from the joint adoption of both strategies are rather similar to the ones stemming from the only introduction of product innovation and both sets of ATTs are higher than the ones estimated for the pure introduction of process innovation. However, when the impact of process innovation is active in $t+1$ the joint innovation strategies are superior than the single ones, as discussed in our theoretical framework.

When we allow for heterogeneous effects across destination market, some interesting findings emerge. Although the results on the export propensity mimic the previous ones, it turns out that complex innovative strategies may have an immediate role in enhancing the firm probability to start exporting to high income economies. We find, indeed, a significant ATT effect at time *t*, that turns non significant at time *t+1*. Thus, the joint adoption of product and process innovation efforts may allow firms to face competition in high income markets. In addition, it is worth to notice that, whereas product innovators are less likely to penetrate such markets, switching from being a product innovator to being a two-way innovator increases the firm probability to start exporting to these destinations both in t and $t+1$. As previously mentioned in our theoretical frame-

[16]This evidence is confirmed even when we estimate ATTs for starting to export only on the sample of firms which were not exporting in *t-1*. By excluding firms exporting in $t-1$ from the control group, we avoid the possibility that non significant ATTs may be driven by the presence of previous exporters in the sample.

work, this evidence suggests that product innovation *per se* is not a sufficient strategy to penetrate such markets for the first time and needs to be complemented by the adoption of new production processes. The marked preference for quality in developed countries goes with a higher production of quality goods in these economies. These latter tend to specialise in higher quality good exports and to intensively exchange among them (Schott, 2004; Hallak, 2006, 2010). It follows a higher thickness of the market for quality, as more quality goods are traded in these economies. This requires the firm willing to start exporting to those destinations to engage in a remarkable quality improvement effort in order to be competitive. For a middle income country's manufacturing firm, then, pure product innovation might not be enough to break into a developed economy and needs to be sustained by an improvement of the firm cost advantage. An alternative explanation of the importance of the joint adoption of the two innovation strategies for the entry in developed countries could follow from the recent increase of offshoring practices led by the latter (Feenstra, 1998). One of their consequences is the relocation of whole production processes in low and middle income economies. Here, the product is only new to the firm that starts to produce it, nevertheless, it is already existing in the foreign market, as many other firms are already producing similar varieties there. The middle income economy firm, then, succeeds in entering the foreign market for the good thanks to the adoption of the new production process which delivers important cost savings, compared to the high income market process. This interpretation highlights that the joint involvement in product and process innovation of middle income economies'firms may actually stem from cost saving process innovations by high income economies' firms.

Turning to the export activity towards low income destinations, in line with our theoretical sketch, product innovation proves rather relevant to export to such destinations. Reduction in costs driven by process innovation could not be enough in order to compete in low labour cost markets. On the contrary, the introduction of new varieties and new products, more than the cost reduction, may be the way for Turkish firms to survive and compete within economies characterised by similar technologies and costs.

Summing up, innovation, namely two-way innovation, stimulates the export start to high income economies only. As mentioned above in our theoretical framework, local entry costs may differ across destinations with low income markets being characterised by lower costs than the high income ones. This may explain why the joint adoption of new products and processes is needed to start to export to the latter markets. On the contrary, the first time entry in low income markets may not require a particular innovative effort and may be simply driven by firm productivity level and size. However, product innovation appears as a key activity to successfully survive in export markets, regardless of the income level. In general, product innovation allows for increased product differentiation, higher mark up and revenues and variable profits. On the one hand, this turns relevant when consumers value quality, as in high income economies. On the other hand, quality upgrading turns to be fundamental when competitors may easily imitate exporters' technology for low quality goods, as in low income economies. Finally, although we modeled two-way innovation as superior compared to each single innovation strategy, comparable returns seem to stem from product and product&process innovation strategies in high income markets. Nevertheless, when the impact of process innovation is significant and positive, i.e. in $t + 1$, the joint adoption of product&process innovation is more rewarding than each single innovation strategy, as predicted by our theoretical framework. On the contrary, the highest coefficient displayed for product innovation in low income destinations could stem from a higher variable cost associated to the introduction of the new process directed to the production of higher quality products.[17] As a matter of fact, higher variable costs may damp the positive effect of new product introduction, so as lower quality could damp the cost advantage from process innovation.

In conclusion, our results support our Hypothesis 1, as we find that firm innovative efforts in an emergent country positively affect the firm export propensity. However, the predicted sorting of innovation strategies summarised in Hypothesis 2 is only confirmed for exporting to high income countries. On the contrary, two-way innovation is not definitely superior to product innovation in preserving the firm position in foreign low income markets. Finally, Hypothesis 3 is corroborated by our data: process innovation plays a role in high income economies more than in the low income ones and the reverse holds for product innovation.

[17] Although our theoretical framework rests on the simplifying assumption of a lower marginal cost related to process innovation, both when adopted alone and in conjunction with product innovation, the production of a higher quality good may require a higher variable cost (Crinò and Epifani, 2012). If this is the case, variable profits may even be lower than those earned under the pure product innovation strategy.

Table 3: ATT effects

	All Countries				High Income Countries				Low Income Countries			
	Exp		Exp_{Start}		Exp		Exp_{Start}		Exp		Exp_{Start}	
	t	t+1	t	t+1	t	t+1	t	t+1	t	t+1	t	t+1
(0,Pc)/(0,0)												
ATT	0.027	0.083	0.005	0.020	0.033	0.082	0.009	0.023	0.062	0.086	-0.042	-0.016
A.s.e	[0.049]	[0.050]*	[0.031]	[0.035]	[0.047]	[0.049]*	[0.029]	[0.033]	[0.048]	[0.048]*	[0.029]	[0.032]
B.s.e	[0.051]	[0.050]*	[0.034]	[0.036]	[0.048]	[0.045]*	[0.030]	[0.031]	[0.045]	[0.045]*	[0.032]	[0.035]
Treated/Controls: 120/827												
(Pd,0)/(0,0)												
ATT	0.090	0.088	-0.017	-0.042	0.119	0.067	-0.001	-0.042	0.125	0.146	-0.013	-0.008
A.s.e	[0.044]**	[0.044]**	[0.025]	[0.026]	[0.044]***	[0.043]	[0.024]	[0.023]*	[0.044]***	[0.044]***	[0.029]	[0.030]
B.s.e	[0.037]**	[0.040]**	[0.026]	[0.028]	[0.036]***	[0.040]*	[0.024]	[0.024]*	[0.039]***	[0.039]***	[0.028]	[0.031]
Treated/Controls: 162 /827												
(Pd,Pc)/(0,0)												
ATT	0.073	0.094	0.027	-0.002	0.084	0.097	0.041	0.016	0.080	0.085	-0.013	-0.014
A.s.e	[0.036]**	[0.036]***	[0.023]	[0.024]	[0.035]**	[0.035]***	[0.022]*	[0.023]	[0.035]**	[0.035]**	[0.023]	[0.024]
B.s.e	[0.033]**	[0.033]***	[0.020]	[0.024]	[0.032]***	[0.032]***	[0.020]**	[0.022]	[0.033]**	[0.034]**	[0.023]	[0.023]
Treated/Controls: 443/827												
(Pd,Pc)/(0,Pc)												
ATT	0.014	0.019	0.009	0.004	0.021	-0.006	0.016	-0.019	-0.021	0.033	0.004	0.023
A.s.e	[0.058]	[0.059]	[0.037]	[0.041]	[0.056]	[0.058]	[0.034]	[0.038]	[0.057]	[0.057]	[0.033]	[0.037]
B.s.e	[0.058]	[0.058]	[0.040]	[0.039]	[0.057]	[0.058]	[0.040]	[0.044]	[0.058]	[0.062]	[0.038]	[0.034]
Treated/Controls: 437/125												
(Pd,Pc)/(Pd,0)												
ATT	-0.014	0.041	0.049	0.047	-0.024	0.071	0.048	0.060	-0.017	-0.014	-0.004	-0.006
A.s.e	[0.050]	[0.050]	[0.029]*	[0.030]	[0.050]	[0.050]	[0.029]*	[0.026]**	[0.050]	[0.050]	[0.032]	[0.033]
B.s.e	[0.045]	[0.048]	[0.027]*	[0.029]	[0.046]	[0.049]	[0.025]*	[0.026]**	[0.046]	[0.047]	[0.031]	[0.031]
Treated/Controls: 441/164												
(0,Pc)/(Pd,0)												
ATT	-0.085	0.006	0.015	0.061	-0.103	0.022	0.002	0.078	-0.070	-0.047	-0.031	-0.009
A.s.e	[0.062]	[0.062]	[0.036]	[0.040]	[0.060]*	[0.061]	[0.034]	[0.037]**	[0.061]	[0.061]	[0.036]	[0.040]
B.s.e	[0.060]	[0.065]	[0.039]	[0.043]	[0.057]*	[0.060]	[0.038]	[0.034]**	[0.059]	[0.058]	[0.038]	[0.043]
Treated/Controls: 119/164												
(Pd,0)/(0,Pc)												
ATT	0.081	0.019	-0.018	-0.047	0.108	0.015	-0.013	-0.056	0.077	0.075	0.034	0.027
A.s.e	[0.062]	[0.063]	[0.038]	[0.041]	[0.061]*	[0.062]	[0.035]	[0.037]	[0.062]	[0.062]	[0.037]	[0.041]
B.s.e	[0.064]	[0.063]	[0.041]	[0.044]	[0.060]*	[0.061]	[0.040]	[0.038]	[0.064]	[0.064]	[0.040]	[0.045]
Treated/Controls: 162/125												

* Significant at 10% level; ** significant at 5% level; *** significant at 1% level. $(0, Pc)$, $(Pd, 0)$, (Pd, Pc) and $(0, 0)$ denote the status of process only, product only, both process and product innovator and non-innovator, respectively. $A.s.e$ and $B.s.e$ stand for analytic and bootstrapped standard errors, respectively.

Robustness Checks. In order to prove the robustness of our results we have implemented some checks. These estimations, in general, confirm all the above findings and are reported in Table A.3 in the Appendix. First, we make use of Radius matching instead of Kernel algorithm allowing a caliper of 1%. Second, we expand the sample including observations from the 2006 CIS wave. This test does not allow to compute the ATT effects for the probability of starting exporting because for firms in the 2006 wave we do not have at our disposal the export activity of own produced goods for the year *t-1* (that is 2003).[18] Third, we report the ATT effects computed when we exploit the export status of own produced goods built making use of a matching between trade and production data implemented according to a correspondence table at a more aggregated level, i.e. between 6 digit Haromised System (HS) trade codes and 6 digit Classification of Products by Activity (CPA) production codes. A final check, not reported for the sake of brevity, consisted in including the growth rate of labour productivity in the logit specification, in order to account for different growth paths between innovators and non-innovators in the pre-innovation period for the control group selection.

6. Concluding Remarks

With this paper we have contributed to the debate about the causal nexus between firm innovation activity and export performance. In particular, for the

[18]In order to build the status of exporter of own produced goods, we need information for production data that, unluckilly are not available before 2005.

first time we have provided evidence on this topic in the context of an emergent economy, Turkey. With respect to previous work, our theoretical framework has pointed at process and product innovation as affecting firm profitability through different channels. As a consequence, our empirical approach, based on a MPSM framework, has isolated the impact of each strategy and of their joint adoption on the firm export propensity. Our evidence, first of all, has corroborated our assumption on the different channels through which product and process innovation operate, thus confirming the need for a separate treatment of the two activities. As a matter of fact, while process innovation is more likely to occur when labour costs are higher and imports from low income economies lower, product innovation is highly probable when firms are intensively engaged in R&D. Furthermore, differently from other empirical papers on the topic, our work has distinguished between the impact of innovation on the export propensity and first time entry into exporting. Results, indeed, have shown that product and process innovation only facilitate the latter activity, when they are jointly undertaken and foreign markets are the developed ones. Nevertheless, in general, innovation strategies have emerged as important to preserve the firm position in export markets. Also, product innovation has appeared as more rewarding in terms of export performance than process innovation, especially for exporting to low income economies, while it is the joint involvement in both activities that has displayed the largest significant impact on the firm export propensity to high income economies.

In conclusion, some policy implications naturally spring from our work. Policy makers in emerging economies, indeed, should sustain the firm innovative efforts in order to preserve its competitiveness in international markets and, especially, to ease its access to advanced countries. However, as from our work innovation alone has not emerged as the only driver of the firm internationalisation, further work should be devoted to shed light on the existence and working of other channels which usually foster the export activity - such as access to financial markets and the expansion of firm size - in the emergent economies' context.

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Appendix

A. Additional Tables and Figures

Table A.1: Multinomial Logit Estimates

	(0, Pc)	(Pd, 0)	(Pd, Pc)
l_{t-1}	0.261**	0.231**	0.222***
	[0.112]	[0.099]	[0.072]
lp_{t-1}	0.034	-0.076	0.262***
	[0.143]	[0.122]	[0.095]
w_{t-1}	0.604**	0.205	-0.044
	[0.235]	[0.210]	[0.153]
$Imp_{Lic\ t-1}$	-0.595**	-0.217	0.15
	[0.262]	[0.236]	[0.170]
$Imp_{Hic\ t-1}$	-0.136	0.054	0.11
	[0.299]	[0.284]	[0.210]
$EmpRD_{t-1}$	0.047	0.089**	0.114***
	[0.051]	[0.035]	[0.028]
$multi_{t-1}$	-0.224	-0.003	0.148
	[0.220]	[0.192]	[0.136]
$Exp_{Hic\ t-1}$	-0.055	-0.008	-0.127
	[0.265]	[0.242]	[0.178]
$Exp_{Lic\ t-1}$	-0.114	0.117	0.235
	[0.242]	[0.220]	[0.160]
$subcont_{t-1}$	0.255	0.176	-0.24
	[0.332]	[0.302]	[0.238]
$outs_{t-1}$	-0.035	-0.046	0.522***
	[0.221]	[0.198]	[0.150]
$Cons$	-26.945	-20.607	-4.887***
	[0.000]	[0.000]	[1.362]
Obs	1,569	1,569	1,569
Pseudo-R^2	0.091	0.091	0.091
Wald Chi^2	322.081	322.081	322.081
Log-Likelihood	-1617.93	-1617.93	-1617.93

* Significant at 10% level; ** significant at 5% level; *** significant at 1% level. $(0, Pc)$, $(Pd, 0)$ and (Pd, Pc) denotes the status of process only, product only and both process and product innovator, respectively.
While the dependent variable concerns the firm innovation activity over the span 2006-2008, labeled as period t, regressors refer to *t-1*, which is year 2005. Two digit sector dummies are included, but not shown for brevity.

Table A.2: Balancing Tests

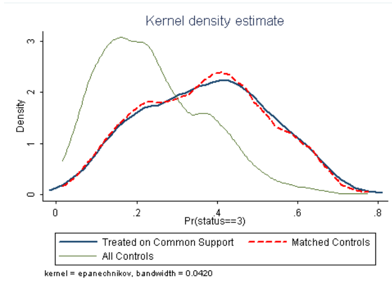
	Treated Firms	Control Firms	% Treated Firms Out of Support	Median Bias Before	Median Bias After	% Drop Bias
(pd,pc) / (0,0)	453	827	2.21	14.49	2.90	79.99
(pd,0) / (0,0)	164	827	1.22	11.07	6.28	43.26
(0,pc) / (0,0)	125	827	4.00	10.29	6.57	36.16
(pd,pc) / (pd,0)	453	164	2.65	11.72	3.79	67.62
(pd,pc) / (0,pc)	453	125	3.53	14.49	7.75	46.56
(pd,0) / (0,pc)	164	125	1.22	12.70	10.49	17.37
(0,pc) / (pd,0)	125	164	4.80	12.70	6.57	48.28

$(0, Pc)$, $(Pd, 0)$, (Pd, Pc) and $(0, 0)$ denote the status of process only, product only, both process and product innovator and non-innovator, respectively. Treated firms are in the common support if their propensity score is lower than the maximum and higher than the minimum score of the control units. In the fifth and sixth column we display the median bias across all the covariates included in the multinomial logit estimation before and after the matching for.

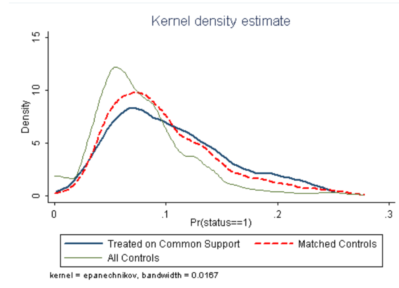
Table A.3: Robustness Checks

	All Countries				High Income Countries				Low Income Countries			
	Exp		Exp_{Start}		Exp		Exp_{Start}		Exp		Exp_{Start}	
	t	t+1	t	t+1	t	t+1	t	t+1	t	t+1	t	t+1
Radius Matching, Caliper 1%												
(0,Pc)/(0,0)	0.035	0.085*	0.011	0.025	0.038	0.083*	0.006	0.020	0.064	0.089*	-0.039	-0.012
(Pd,0)/(0,0)	0.091**	0.091**	-0.014	-0.038	0.118***	0.067	0.002	-0.039	0.132***	0.151***	-0.012	-0.009
(Pd,Pc)/(0,0)	0.082**	0.095**	0.026	-0.001	0.089**	0.094**	0.040*	0.018	0.086**	0.088**	-0.009	-0.012
(Pd,Pc)/(0,Pc)	0.043	0.035	0.029	0.005	0.036	0.005	0.038	-0.004	0.003	0.051	0.023	0.045
(Pd,Pc)/(Pd,0)	-0.015	0.016	0.055*	0.055*	-0.032	0.029	0.050*	0.066**	-0.033	-0.044	0.002	0.001
(0,Pc)/(Pd,0)	-0.095	0.028	0.003	0.060	-0.105*	0.042	-0.007	0.080**	-0.072	-0.028	-0.046	-0.011
(Pd,0)/(0,Pc)	0.098	-0.001	-0.012	-0.036	0.156**	0.059	0.002	-0.049	0.088	0.040	0.036	0.032
Pooled, 2 Waves												
(0,Pc)/(0,0)	0.031	0.091**	-	-	0.041	0.092**	-	-	0.065	0.086**	-	-
(Pd,0)/(0,0)	0.079**	0.075*	-	-	0.106***	0.059	-	-	0.111***	0.129***	-	-
(Pd,Pc)/(0,0)	0.069**	0.091**	-	-	0.079**	0.089***	-	-	0.071**	0.080**	-	-
(Pd,Pc)/(0,Pc)	0.025	0.027	-	-	0.026	-0.008	-	-	-0.015	0.029	-	-
(Pd,Pc)/(Pd,0)	0.010	0.049	-	-	-0.011	0.056	-	-	0.002	0.002	-	-
(0,Pc)/(Pd,0)	-0.054	0.039	-	-	-0.071	0.052	-	-	-0.048	-0.028	-	-
(Pd,0)/(0,Pc)	0.078	0.014	-	-	0.095*	0.002	-	-	0.074	0.067	-	-
Produced Goods, 6digit Matching												
(0,Pc)/(0,0)	-0.039	0.039	-0.016	0.025	-0.023	0.044	0.001	0.032	0.018	0.079	-0.050	0.004
(Pd,0)/(0,0)	0.090**	0.062	0.006	-0.024	0.098**	0.066	-0.009	-0.027	0.130***	0.155***	0.004	0.013
(Pd,Pc)/(0,0)	0.085**	0.086**	0.058***	0.027	0.084**	0.085**	0.053**	0.027	0.099***	0.094***	0.029	0.022
(Pd,Pc)/(0,Pc)	0.097*	0.065	0.039	0.011	0.090	0.029	0.026	-0.019	0.042	0.040	0.024	0.013
(Pd,Pc)/(Pd,0)	0.003	0.056	0.055*	0.046	0.006	0.070	0.065**	0.053*	-0.003	-0.013	0.013	-0.006
(0,Pc)/(Pd,0)	-0.160***	-0.019	-0.030	0.054	-0.149**	-0.017	-0.001	0.071*	-0.129**	-0.070	-0.063*	-0.005
(Pd,0)/(0,Pc)	0.160**	0.053	0.012	-0.042	0.170***	0.075	-0.016	-0.054	0.131**	0.098	0.037	0.006

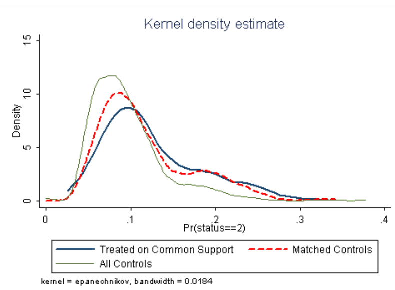
* Significant at 10% level; ** significant at 5% level; *** significant at 1% level. Significance levels rest on bootstrapped standard errors. $(0, Pc)$, $(Pd, 0)$, (Pd, Pc) and $(0, 0)$ denotes the status of process only, product only, both process and product innovator and non-innovator, respectively.



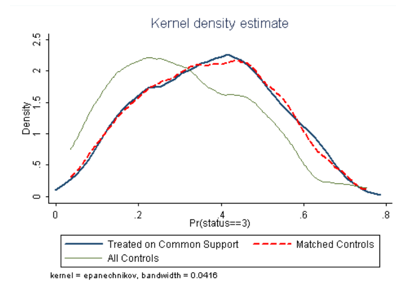
(a) (Pd,Pc)/(0,0)



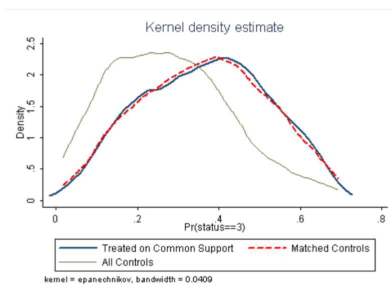
(b) (0,Pc)/(0,0)



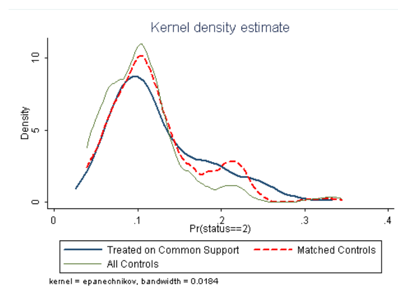
(c) (Pd,0)/(0,0)



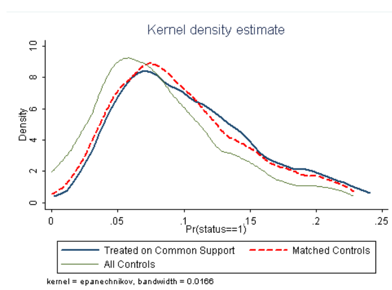
(d) (Pd,Pc)/(Pd,0)



(e) (Pd,Pc)/(0,Pc)



(f) (Pd,0)/(0,Pc)



(g) (0,Pc)/(Pd,0)

Figure A.1: Propensity score densities for the treated, matched and unmatched controls