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New stuff or better ways: what matters to access international markets?

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ABSTRACT

The connection of innovation and exporting is of major interest to developing countries aiming to achieve higher growth and well-being. This study analyzes whether different types of innovation affect export behavior at the firm level for an unbalanced panel of Uruguayan manufacturing firms. Logistic regression and matching with difference-in-differences (MDID) techniques are applied to data from 2003 to 2012. Unlike other studies, productivity-enhancing (or cost-reducing) innovation shows a stronger correlation with exporting than product innovation, indicating that price competition is more important than quality competition for Uruguayan products in foreign markets. Furthermore, using MDID we establish a direct causal link from innovation to exporting. Finally, the causal effect of innovation on exporting is mainly found for exports to countries belonging to the regional trade agreement Mercosur. Overall, the findings indicate that active innovation policies along with other export promotion policies would help promote firms' participation in foreign markets.

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Product innovation; process innovation; exporting; dif in dif; matching

1. Introduction

Innovation can come out as gift from luck, but largely it is the result of a process purposely put in motion to generate better responses to a problem. In economics and business, we tend to focus on two types of innovations: those that provide new products to satisfy the taste of more demanding clients, and innovations that improve the way that the old stuff is produced, marketed, or delivered. In this work, we analyze the impact of those types of innovations on exporting behavior, as well as the impact when exporting to different markets, from a firm level perspective using micro level data from Uruguayan manufacturing firms.

From a macroeconomic standpoint, innovation is often considered a source of international competitive advantage likely to improve the trade balance and boost economic growth (Rodil, Vence, & Sánchez, 2015). At the firm level, innovation is expected to increase productivity and more productive firms are more likely to engage in international markets (Caldera, 2010). Participation in foreign markets can also prompt up further innovation, as firms have to deal with new competitive pressures while being

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exposed to new sources of knowledge. Hence, exporting may be a consequence as well as a cause of innovation suggesting an endogenous relationship between both, exports, and innovation.

There is already a growing literature debating the double-edged relationship between innovation and exports (Damijan, Kostevc, & Polanec, 2010; Filipescu, Prashantham, Rialp, & Rialp, 2013; Van Beveren & Vandenbussche, 2010). The novelty of this study is its focus on a small open economy for which the existent literature is scarce. Since the 1990s, Uruguay has engaged in a process of structural reforms and trade liberalization without major setbacks despite the serious economic crisis of 2002. Considering the reduced size of the local market and the increasing competition from abroad, thriving in international markets has become increasingly important for Uruguayan firms and a pressing issue for public policy design. A study of Uruguayan manufacturers can provide useful cues to other developing countries. These are firms operating in a traditionally commodity-oriented country, where most of its manufacturing industry developed under protectionist rules that have been reversed from the mid-1970s onwards.

We want to know whether innovation fosters internationalization[1] and what type, if any, of innovations are more relevant in that process. It has been reported that innovation is less important to enter export markets in less developed countries, because firms tend to compete based on access to existing resources (Cirera, Marin, & Markwald, 2015). Nevertheless, lack of innovation can hinder gains in efficiency but also the process of export diversification. To foster innovation both in terms of new products and new ways of production is necessary to accelerate the catching-up process with more developed countries.

Whether or not innovation helps firms enter and survive international markets is important for business decision-making and policy recommendations. We hypothesize that innovation would increase exporting entry and participation into foreign markets.

We use an unbalanced panel of 1,678 Uruguayan manufacturing firms surveyed between 2003 and 2012 by the National Agency of Research and Innovation (ANII). This period is covered by four surveys for the years 2003, 2006, 2009, and 2012.[2] These surveys are referred as EAII, which stands for *Encuestas de Actividades de Innovación en la Industria* (Innovation Activities Surveys). Each of these surveys provides information on reported innovation and exporting activities, as well as a wide variety of firm's characteristics.[3]

The surveys contain rich information on the various types of innovation outputs as well as inputs such as R&D internal and external investment. For this study, we mainly rely on innovation output measures, in particular, the type of innovation reported by firms. Innovative activity can be aimed at (1) the introduction of new products in order to increase variety; (2) enhancing the efficiency in the production process or (3) improving the commercialization of already existing products; and/or (4) implementing new organizational methods in business practices. The data set allows us to identify all four types of innovation outputs: product, process, commercialization, and organization, respectively.

[1]Due to data availability we have to focus only on exports.
[2]The survey for 2015 became available in 2019 but it was not at the time this article was written.
[3]Unfortunately, EAII 2000 survey lacks information on a number of important variables such as exports, type of innovation, and sales. Therefore, even though we have the data at hand, information from this particular year is not used in the analyses.

Product and process innovation have received most of the attention in the literature while the effects of organizational innovation on economic performance remain relatively unknown (Love & Roper, 2015).[4] Indeed, organizational innovation is often considered within the process innovation category and commercialization innovation is barely mentioned. For the purpose of this study, we will make a distinction between product and the other three types of innovation. The rationale is that product innovation aims to satisfy demand by offering something new, while the other types of innovation seek to improve at least one aspect of the production and delivery process of already existing goods. The manufacture of new products may or may not be more efficient than the old ones, and therefore productivity gains are not guaranteed (Harrison, Jaumandreu, Mairesse, & Peters, 2014). On the other hand, process, commercialization, and organizational innovations are expected to deliver productivity gains. Henceforth, we will refer to these three types as productivity-enhancing innovations. This classification of innovative firms is similar to that used by Cassoni and Ramada-Sarasola (2015) also working with Uruguayan data.[5]

We are interested in the relationship between innovation and exports. Thus, the purpose of this study is to provide an answer to two questions. First, does innovation affect firms' entry into export markets?; and second, if so, what is more important for Uruguayan firms in order to access foreign markets, to introduce new products or to produce more efficiently? The questions can be associated with the following non-exclusive two hypotheses, since also some complementarity may exist between product and productivity-enhancing innovations. First, product innovation may affect the exporting status of firms more than the other forms of innovation. The introduction of a new product pushes firms towards international markets. An alternative interpretation would state that firms planning to expand their business abroad adapt their products to the destination markets. In either case, product innovation increases the probability of exporting behavior in the following period more than any other type of innovation. Second, productivity-enhancing (cost-reducing) innovations affect the exporting status of firms more than product innovation. Innovations that reduce production cost allow firms to enter into international markets. An alternative interpretation would be that firms planning to expand their business abroad need to reduce costs first in order to be competitive. In either case, process innovation, organizational innovation, and/or commercialization innovation are more important in order to participate in international trade.

The empirical literature provides at best mixed results. Some works find that innovation is important to enter into foreign markets, while the effects of product and process innovation seem to point out that product innovation is more important for developed countries than for developing economies.

The empirical strategy is designed in three steps. First, panel data logit models offer a first approximation of the association between innovation and exports. Second, we use propensity score matching with differences in differences (MDID) to explore the causal

[4]Organizational innovation: refers to innovation resulting from an improvement in the organization and internal management of the firm, this can result for example due to improvements in the business management that involves the elimination of duplicate costs in the firm, a management of the work that improves the production, etc.

[5]Previous studies have shown a considerably larger impact of process innovation on productivity than that of product innovation for Uruguayan manufacturing firms (Cassoni & Ramada-Sarasola, 2010).

relationship between both variables and finally we distinguish between exports to Mercosur and exports to the rest of the world.

The main results suggest that productivity-enhancing innovation predicts exporting behavior better than product innovation does. Moreover, there is evidence of a causal relationship that goes from innovation to exports. This result may be explained due to the trade specialization of the country, based in commodity goods – such as meat, soy beans and rice – with a low degree of differentiation. However, when distinguishing by destination we find that product innovation also causes exports for Mercosur importers, whereas the causality cannot be established for exports to the rest of the world. This latter result indicates that Uruguayan firms are able to sell new products to their neighbors but not to further away destinations.

The rest of the paper is organized as follows. Section 2 summarizes the closely related literature. Section 3 outlines the empirical strategy, describing the methodology, data, and variables. Section 4 presents the main results and Section 5 concludes.

2. Literature review

Previous studies have found a strong and positive correlation between innovation, exporting, and performance. Some suggest the existence of complementarities between innovation and exporting, meaning that the combination of both is required to obtain substantial productivity gains (Love, Roper, & Hewitt-Dundas, 2010). But other research have found no significant interaction between them (Monreal-Pérez, Aragón-Sánchez, & Gregorio, 2012). Nevertheless, it is well established in the literature that exporting firms are more productive than the non-exporting and they are so even before they started exporting (Bernard & Bradford Jensen, 1999; Melitz, 2003).

Whether firms gain productivity before exporting, and to what extent exporting induces productivity gains, are two independent questions addressed in the literature. It is possible that causality runs in both directions, from productivity gains to exporting and from exporting to higher productivity. The problem can be summarized in three non-exclusive hypotheses: self-selection, conscious self-selection or anticipation, and learning-by-exporting.

Self-selection in terms of productivity simply means that more productive firms are more likely to become exporters (Eliasson, Hansson, & Lindvert, 2012; Love & Roper, 2015; Monreal-Pérez et al., 2012; Ricci & Trionfetti, 2012; Wagner, 2007). A variant of the former hypothesis would be conscious self-selection or anticipation (Alvarez & Lopez, 2005; Costantini & Melitz, 2007; Iacovone & Javorcik, 2012; Van Beveren & Vandenbussche, 2010). Exporting firms were more productive before exporting because they consciously invested on enhancing their productivity in order to access international markets.

While self-selection into exporting is overwhelmingly supported by the literature, there is no such consensus on the learning-by-exporting hypothesis. Many studies found no significant effect of exporting on productivity (Clerides, Lach, & Tybout, 1998; Ganotakis & Love, 2011; Monreal-Pérez et al., 2012). Others found increasing productivity before entering the export market but not afterwards, supporting the hypothesis of anticipation (Bernard & Bradford Jensen, 1999; Clerides et al., 1998; Eliasson et al., 2012; Kim, Gopinath, & Kim, 2009; Love & Roper, 2015). For some countries however

favorable evidence to the learning-by-exporting hypothesis has been found. The country studies include the Taiwanese electronics industry (Aw, Roberts, & Winston, 2007); Japanese firms (Kimura & Kiyota, 2006); the United Kingdom; Slovenia (Damijan et al., 2010; De Loecker, 2007); Spanish manufacturing firms (Hanley & Joaquín, 2012); Indonesian manufacturing (Blalock & Gertler, 2004); Colombian manufacturing (Fernandes & Isgut, 2007). Evidence of learning by exporting was also found for Uruguayan firms that start exporting to less developed countries (Barboni, Ferrari, Melgarejo, & Peluffo, 2012).

To draw a clearer picture of the link between innovation and export we ought to consider investment decisions. Investing to improve productivity before exporting is consistent with both the self-selection and anticipation hypotheses. Bear in mind that investment is actually an input whose expected output can be some sort of innovation that boosts productivity but not all forms of innovation necessarily increase productivity. Since productivity correlates with exporting, then the association between productivity and exports may be partially explained by investment and productivity-enhancing innovations (Cassiman, Golovko, & Ester, 2010; Peluffo, 2016).

It is possible that firms invest in enhancing productivity due to their willingness to enter international markets, in which case productivity-enhancing innovation may be endogenous with respect to the decision to export (Alvarez & Lopez, 2005; Van Beveren & Vandenbussche, 2010). The decision to innovate may respond to the anticipation of a liberalization process either because firms expect to reap the benefits of easier access to external markets or because they anticipate fierce competition from entering foreign firms (Costantini & Melitz, 2007). It could be the case that innovative firms enter foreign markets to increase or to compensate sales when local demand falls (Monreal-Pérez et al., 2012). A countercyclical pattern of innovation propensity has been found among Uruguayan firms coping with the crisis of the early 2000s (Cassoni & Ramada-Sarasola, 2015).

There is no consensus in the literature regarding the causal impact of innovation on exporting propensity/intensity (i.e., exporting probability). The majority of studies show a positive impact of innovation on exports (Cassiman et al., 2010; Leonidou, Katsikeas, Palihawadana, & Spyropoulou, 2007; Monreal-Pérez et al., 2012; Wagner, 2007). Self-selection into exporting and innovation cannot be ruled out as more productive firms are more likely to engage in both activities (Ganotakis & Love, 2011). There are studies in which no evidence was found that either product or process innovation increase the probability of becoming an exporting firm (Damijan et al., 2010). Cassiman et al. (2010) find for a panel of Spanish manufacturing firms that product innovation is a very important driver of exports. Lo Turco and Maggioni (2015) find for Turkey that innovation strengthens firms' export probability. Product innovation matters for exporting to developing economies, while process innovation reinforces the role of product innovation for exporting to richer markets. Halpern and Balázs (2012), using innovations survey data merged with customs data, find that innovative firms are more productive, more likely to trade and export more products to more countries. An odd case is Wakelin (1998) who found that among UK firms, when size is controlled for, innovating firms are actually less likely to export. It seems that the small British innovative firms do not feel the pressure to look for costumers abroad and concentrate in domestic markets instead.

The interaction between innovation and exports is complex and causality is likely to operate in both directions. For instance, some studies have focused on investigating

whether the causality runs from exporting to innovation. Selling in a foreign market is a challenge that redefines firms and entry and survival in exports markets requires adaptation either through productivity gains (price) or through the introduction of new products to accommodate foreign tastes (quality). In this sense, exports may affect innovation through three main channels. First, stronger competition faced in external markets would force firms to improve products and processes. Second, firms will be exposed to foreign knowledge and will acquire information from foreign customers (Salomon & Myles Shaver, 2005). Knowledge acquired in foreign markets allows firms to register more patents and develop new products. Third, exporting firms can benefit from economies of scale that make costly innovations more profitable (Pla-Barber & Alegre, 2007; Rodil et al., 2015).

In this paper, we will make no assumption about the reasons behind the observed innovative behavior of firms. The first question we want to answer is whether innovation affects entry into export markets, and what type of innovation is more important to entry into foreign markets for Uruguayan manufacturing firms. The second question is whether the link between innovation and exporting varies by export destination. We acknowledge that the causality could be bidirectional and hence innovation is considered as endogenous in our estimated models.

3. Empirical strategy

The baseline analysis consists in the implementation of logit regression for panel data. Since these models do not account for selection into the treatment, its results cannot be given a proper causal interpretation. A more accurate approach follows, which consists in the application of matching with difference-in-differences (MDID).

3.1. Methodology

The probability of exporting ($EX = 1$) will be treated as a binary response outcome. Exporting is the outcome variable ($Y = EX$), and starting to innovate is the treatment variable ($T = IN$). Four different types of innovation are considered, namely product, process, commercialization, and organizational innovations, modeled as binary variables that can take *0* or *1* values.

The corresponding models look as follows (Rabe-Hesketh & Skrondal, 2008):

$$logit\{Pr(EX_{it} = 1|IN_{it}, X_{it})\} \equiv ln\left\{\frac{Pr(EX_{it} = 1|IN_{it}, X_{it})}{1 - Pr(EX_{it} = 1|IN_{it}, X_{it})}\right\} = \beta_0 + \beta_1 IN_{it} + \beta_2 X_{it} \quad (1)$$

The covariates included in X are: Firm size measured by number of employees; foreign ownership of capital defined as a dummy equal one if the firm has foreign capital participation; absorptive capacity proxy by the share of skilled workers and/or spending in R&D per worker; year dummies to control for macroeconomic shocks and other contextual changes; and, industry dummies to control for industry-specific effects.[6]

[6]Greenaway and Kneller (2007) show that the potential learning from exports effect is lower for industries already exposed to high level of international competition and high intensity of R&D.

We expect that size of the firm is positively associated with exporting, while the presence of foreign capital indicates a certain degree of internationalization that distinguishes the firm from the nationally owned. The propensity to export among foreign-owned firms may be different even in the absence of any kind of innovations. Furthermore, international links have been shown to affect the productivity of Uruguayan firms (Peluffo, 2012) and, as we discussed before, productivity is related to exports and innovation.[7]

Regarding our proxies for absorptive capacity, innovation in developing countries largely relies on absorption and adaptation of what has been done elsewhere, so a shortage of skills can be an important handicap for firms willing to produce or incorporate technology. Investment in R&D and the proportion of skilled workers are two proxies for absorptive capacity. Investment in R&D is an innovation input that correlates with innovation outcomes, but usually is very low in small developing economies.[8]

Logit models are useful to explore the correlation between exporting and innovation but they cannot provide a reliable estimate on the causal effect between the former variables. That is because this technique does not solve the problem of selection bias. Both innovation and exporting usually are randomly assigned, and firms select themselves into these activities.

To circumvent this problem, we rely on propensity score matching (PSM) and matching with difference-in-differences (MDID). These methods tackle not only the endogenous nature of innovation, but also the influence of common macroeconomic shocks (Blundell & Costa Dias, 2000; Girma, Greenaway, & Kneller, 2003; Greenaway & Kneller, 2007; Hanley & Joaquín, 2012).

PSM techniques create a control group matching treated individuals with non-treated that are as similar as possible based on a set of observable characteristics that are assumed to be unaffected by the treatment but are statistically related to the probability of receiving such treatment. For example, if innovation is the treatment, then firms that did engage in innovation activities are going to be matched with similar firms that had a similar probability of becoming innovators but for some reason did not. The average difference in outcomes for these two kinds of firms will be attributed to the impact of the treatment.

The Average Treatment Effect on the Treated (ATT) can be expressed as follows:

$$ATT = \{Pr(EX_{it} = 1|IN_{it} = 1, PS(X)) - Pr(EX_{it} = 1|IN_{it} = 0, PS(X))\} \qquad (2)$$

In the first stage, we use a logit model to estimate the propensity score (PS) as the conditional probability of receiving treatment (T), i.e. export status based on the lagged values of the following variables: lagged firm size measured as the total number of workers employed (*Workers*) and sales in constant pesos; absorptive capacity proxied by the share of skilled workers, and investments in R&D per worker.[9] We also introduce

[7]It is confirmed in the empirical literature that exporters exhibit a higher productivity levels than non-exporters (see ISGEP (2008) for a large international survey).
[8]Results using R&D that turn out to be not significant are available upon request from the authors.
[9]The share of skilled workers represents the sum of the share of professionals and the share of technicians in the total number of workers employed by the firm.

a dummy variable that takes the value of one if the firm is foreign owned lagged one year,[10] as well as industry and time dummies.

The matching can be done using different techniques.[11] Nearest-neighbor matches each treatment unit with one – or more – comparison unit(s) based on score proximity. We employed this technique using 5 nearest neighbors. As robustness, we also used kernel and local linear matching, nonparametric estimators that use a weighted average of all non-participants to create the counterfactual match (Khandker, Koolwal, & Samad, 2010).

3.2. Data and variables

We have at our disposal four waves of the Innovation Activities Surveys (Encuestas de Actividades de Innovación en la Industria – EAII) collected by the National Agency of Research and Innovation (Agencia Nacional de Investigación e Innovación – ANII). Each survey was delivered every three years by the National Bureau of Statistics (Instituto Nacional de Estadísticas – INE) following the guidelines established in the Bogotá Manual (Jaramillo, Lugones, & Salazar, 2001).[12] For this study we use data corresponding to the years 2003, 2006, 2009, and 2012.

Surveys combine two inclusion criteria: (1) compulsory participation for big firms[13]until 60 percent of employment within the industry is covered – after such a quota is filled, some big firms may be exempt from the survey-; (2) representative random selection of small and medium firms stratified by industry. Two public firms and one mixed-capital firm were excluded from the analysis.[14] The remaining data contains information on 1,678 privately owned firms of whom 275 are observed throughout the full period. On the other hand, 517 firms are observed only once and therefore cannot be used for panel data analysis. Information is collected through personal interviews that are compulsory for all the sampled firms.

Innovation is introduced in the models in three different ways. First, the basic models include a binary variable taking value 1 when the firm reported any type of innovation. Second, four binary variables corresponding to each type of innovation reported by the surveys: product, process, commercialization, and organizational. Third, three binary variables representing three possible combinations: (1) when "only product" innovation was reported, (2) when "product and other" form of innovation was reported, or (3) "any but product" form of innovation.

Statistical correlation between the various types of innovation is high.[15] Nevertheless, having four kinds of innovations is an asset of the data (Table A.2 in the Appendix shows

[10]Foreign firms are important determinant, both for innovation as well as export behavior. While it is reasonable to assume that the intensity of foreign ownership matters lack of data prevents us from including the shares of foreign ownership to shed more light on its role for both activities.

[11]Estimation of propensity scores and the following matching of observations was done in STATA, using the command "*psmatch2*" (Leuven & Sianesi, 2015). The same command was used to produce the MDID estimates of the Average Treatment Effect on the Treated (ATT).

[12]The Bogota Manual (OECD, 2006) is the adapted version for Latin America of the Oslo Manual (Eurostat, 2005).

[13]Participation in EAII Surveys is mandatory for firms that either reported: (A) more than 50 employees in 2000, 2003, and 2006, or 100 employees from 2009 onwards; or (B) annual sales are higher than: 13 million Uruguayan pesos (EAII 2000); 1 million American dollars (EAII 2003); 25 million of Uruguayan pesos (EAII 2006); $U 120 million (EAII 2009). Additionally, some activities are defined as mandatory inclusion regardless of size.

[14]The exclusion of the state-owned oil refinery (ANCAP) produces important changes in the composition of the sample, since it is by far the biggest firm in the sample and we excluded it from the sample because it is clearly an outlier.

[15]See Table A1 in the Appendix.

the number of observations for each type of innovation used in the model), since some previous studies have found that combining different types of innovation was crucial for exporting (Greenaway & Kneller, 2007). From 2003 to 2012 there is information on export intensity defined as the value of exports over total sales. With that information, we have created a binary variable indicating whether the firm has reported any sort of exporting activity.

Regarding productivity, we must state that the lack of information on capital prevent us from estimating total factor productivity (TFP), thus we have to rely on a simple measure of labor productivity: sales per worker (Ricci & Trionfetti, 2012). All the monetary values are deflated by the corresponding price index with 2003 as base year, so expressed in constant pesos.[16]

3.3. Stylized facts

At the international level, the literature shows that exporting firms are bigger in terms of employment and output, more capital intensive, pay higher wages and are more productive, in line with the empirical literature (Aw and Hwang, 1995; Bernard & Bradford Jensen, 1999; Cassiman et al., 2010; Clerides et al., 1998; Delgado, Farinas, & Ruano, 2002). We can observe that Uruguayan exporting firms also tend to be bigger both in terms of sales and the number of workers they employ (Barboni et al., 2012). Within exporters and non-exporters alike, innovative firms tend to be bigger than their non-innovative counterparts (Table 3).

Considering labor productivity (ratio of sales per worker), exporting firms are notoriously more productive than non-exporting firms. Innovative firms are also more productive than non-innovating, but the difference disappears once exporting status is taken into account. Indeed, Table 1 shows that non-innovating exporters are the more productive in terms of labor productivity.

Among innovating firms, those with exporting activity invest much more heavily in R&D than those that do not export. The difference is not only evident in absolute terms – exporting firms are bigger so this is unsurprising – but also as a ratio of R&D investment per worker, which is more than twice in exporting firms.

Foreign networks reduced the cost of acquiring information about foreign markets and are usually associated with a higher probability of exporting (Ricci & Trionfetti, 2012a). From Table 1 we see that the presence of foreign capital is clearly more preeminent among exporting firms. We observe that foreign capital is always associated with bigger firms: in all categories firms that are wholly or partially owned by foreigners represent a bigger share of the labor force and an even bigger share of sales. For example, less than a quarter (22.6%) of non-innovating exporting firms presents some degree of foreign capital ownership. These firms represent 39% of employment and 54.5% of sales within the category.

In Table 2, we present the number and share of exporters and non-exporters according to whether they undertake innovation activities or not. Furthermore, we show the number and percentage of different types of innovation and the combination of them. In

[16]The exchange rate between Uruguayan pesos and US dollars was of 29.24 in 2003 (Banco Central del Uruguay). https://www.bcu.gub.uy/Estadisticas-e-Indicadores/Paginas/Cotizaciones.aspx.

Table 1. Main characteristics of firms according to exporting and innovation status, 2003–2012.

	Non-Exporters			Exporters		
	Non-Innovators	Innovators	All Non-Exporters	Non-Innovators	Innovators	All Exporters
Age of the Firm (years)	25.1	29.3	26.6	29.9	35.9	33.5
Employment (number of workers)	31.5	58.5	41	107.8	181.4	152.0
Share of Skilled Workers	8.2	12.4	9.7	8.7	12.8	11.2
Avg. Sales[a] (constant pesos)	34.9	87.2	53.2	279.1	540.1	435.1
Sales/Worker	1.0	1.1	1.0	4.3	3.6	3.9
R&D per Worker[a] (constant pesos)	0	0.8	0.1	0	1.7	0.3
Foreign Capital (% of firms)	3.2	6.3	4.3	22.6	28.3	26.0
Number of Observations	1,365	733	2,098	518	769	1,287

Notes: [a]Thousands of constant pesos, base year 2003. Own elaboration based on survey information provided by ANII.

Table 2. Number and share of exporters and innovators (2003–2012).

	Non-Innovators			Innovators			Non-Exporters			Exporters		
Survey	All	Exporters	%	All	Exporters	%	All	Innovators	%	All	Innovators	%
2003	407	111	27.3	404	216	53.5	484	188	38.8	327	216	66.1
2006	470	153	32.6	364	200	54.9	481	164	34.1	353	200	56.7
2009	510	128	25.1	412	199	48.3	595	213	35.8	327	199	60.9
2012	496	126	25.4	322	154	47.8	538	168	31.2	280	154	55
Total	1,883	518		1,502	769		2,098	733		1,287	769	

Notes: Authors' own calculations.

the sample 1,883 observations report no innovation. In 1,502 cases at least one type of innovation was reported: 134 observations reported only product innovation and not any other type, 690 observations correspond to product along with any other type of innovation, and 644 correspond to any innovation except for product. There are also 190 cases in which all four types were reported.

4. Empirical results

We start by addressing the impact of innovation activities on exporting behavior, namely whether innovation, and type of innovation (product or process) affects the entry into foreign markets. Our dependent variable is export status, a binary variable that takes the value of one if the firm exports and zero otherwise. Then, we analyze causal relations using MDID techniques.

In Table 3, we present logit models that differ in how the treatment is defined keeping the same set of covariates (The top part of Table 3 shows the estimated coefficients and the bottom part shows the marginal effects). We use random effect logit models since the fixed effect models in some specifications did not achieve convergence and also because due to the lack of variation of some covariates those models have a poor explanatory power. There are certain regularities that transcend any particular specification. First, larger firms in terms of employment and firms with a larger share of skilled workers are

MARGINAL EFFECTS	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	All	Product	Process	Commercial	Organizational	Several	Several
$Innovation_{it-1}$	0.066**	0.0333	0.0508**	0.0585*	0.0679**		
	(0.0262)	(0.0275)	(0.0253)	(0.0327)	(0.0277)		
Only Product Inn_{it-1}						0.0596	0.0584
						(0.0554)	(0.0536)
Product and Other Inn_{it-1}						0.0670**	
						(0.0303)	
Enhancing Inn_{it-1}						0.0635**	0.0653**
						(0.0321)	(0.0263)
Medium $Size_{it-1}$	0.2388****	0.245***	0.243***	0.245***	0.242***	0.239***	0.239***
	(0.0285)	(0.0282)	(0.0283)	(0.0280)	(0.0282)	(0.0285)	(0.0285)
Big $Size_{it-1}$	0.4745***	0.486***	0.482***	0.484***	0.479***	0.475***	0.475***
	(0.0007)	(0.0410)	(0.0410)	(0.0411)	(0.0412)	(0.0414)	(0.0414)
Age_{it}	0.00046	0.000487	0.000463	0.000493	0.000487	0.000473	0.000472
	(0.0008)	(0.000779)	(0.000777)	(0.000782)	(0.000781)	(0.000779)	(0.000779)
Share Skilled $Workers_{it-1}$	0.0014	0.00154	0.00149	0.00154	0.00145	0.00136	0.00135
	(0.0012)	(0.00121)	(0.00121)	(0.00121)	(0.00121)	(0.00122)	(0.00121)
Ln(Sales/Worker)it-1	0.1626***	0.165***	0.163***	0.165***	0.166***	0.163***	0.163***
	(0.0166)	(0.0166)	(0.0166)	(0.0167)	(0.0166)	(0.0167)	(0.0167)
R&D per $Worker_{it-1}$	0.0038	0.00420	0.00401	0.00379	0.00376	0.00383	0.00384
	(0.0033)	(0.00336)	(0.00335)	(0.00342)	(0.00342)	(0.00335)	(0.00335)
Foreign Owned $Firm_{it-1}$	0.199***	0.198***	0.196***	0.196***	0.194***	0.209***	0.198***
	(0.0461)	(0.0460)	(0.0459)	(0.0457)	(0.0458)	(0.0477)	(0.0461)
Observations	1,879	1,879	1,879	1,879	1,879	1,879	1,879
Time Dummies	YES	YES	YES	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES	YES	YES	YES

Notes: Enh.Inn: includes process, organizational and commercialization innovations aimed at enhancing productivity. Standard errors in parenthesis; *** p < 0.01, ** p < 0.05, * p < 0.1; dy/dx for factor levels is the discrete change from the base level.

more likely to export; second, the presence of foreign capital also increases the likelihood of exporting; finally, labor productivity is always positive and significant.

The relationship between lagged innovation and exporting status depends on how we define the treatment. When we include each type of innovations represented by a single binary variable (*Innovation*), lagged innovation has a positive and significant impact on the probability of exporting (Model 1–5).[17] The results show that apart from product innovation (Model 2), the other three types show statistically significant coefficients. Model 6 presents mutually exclusive innovation categories and its interaction. Again, product innovation alone shows no significant association with export status, while the combination of any type of innovation positively relates to exporting status. The combination of product innovation with any other type is significant. Finally, in Model 7 we observe that productivity-enhancing innovation – i.e. the firm has undertaken process, organizational, or commercialization innovation – shows a positive and significant impact on exports while product innovation alone does not.

[17]When we exclude labor productivity as control process innovation is positive and significant but product innovation is not significant. Results are available upon request from the authors.

Table 3. Innovation and export activity: logit model results.

COEFFICIENTS	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	All	Product	Process	Commercial	Organizational	Several	Several
Innovation	0.697**	0.351	0.535**	0.633*	0.720**		
	(0.276)	(0.289)	(0.266)	(0.363)	(0.295)		
Only Product Inn_{it-1}						0.627	0.628
						(0.593)	(0.592)
Product & Other Inn_{it-1}						0.669**	
						(0.338)	
Enhancing Inn_{it-1}						0.706**	0.689*
						(0.326)	(0.279)
Medium $Size_{it-1}$	3.099***	3.214***	3.165***	3.258***	3.207***	3.117***	3.112***
	(0.496)	(0.499)	(0.496)	(0.499)	(0.500)	(0.498)	(0.497)
Big $Size_{it-1}$	5.695***	5.867***	5.793***	5.934***	5.862***	5.722***	5.712***
	(0.642)	(0.647)	(0.642)	(0.644)	(0.645)	(0.647)	(0.643)
Age_{it}	0.00483	0.00511	0.00485	0.00523	0.00516	0.00496	0.00465
	(0.00818)	(0.00820)	(0.00816)	(0.00831)	(0.00830)	(0.00820)	(0.00819)
Share Skilled $Workers_{it-1}$	0.0143	0.0162	0.0156	0.0163	0.0154	0.0143	0.0142
	(0.0127)	(0.0127)	(0.0127)	(0.0128)	(0.0128)	(0.0128)	(0.0128)
Ln(Sales/Worker)it-1	1.702***	1.734***	1.711***	1.749***	1.758***	1.710***	1.707***
	(0.197)	(0.199)	(0.198)	(0.199)	(0.200)	(0.199)	(0.198)
R&D per $Worker_{it-1}$	0.0399	0.0440	0.0420	0.0402	0.0399	0.0402	0.0403
	(0.0350)	(0.0352)	(0.0351)	(0.0362)	(0.0362)	(0.0351)	(0.0351)
Foreign Owned $Firm_{it-1}$	2.200***	2.197***	2.169***	2.205***	2.190***	2.198***	2.196***
	(0.515)	(0.514)	(0.513)	(0.519)	(0.521)	(0.516)	(0.516)
Observations(a)	1,879	1,879	1,879	1,879	1,879	1,879	1,879
Number of id	1,089	1,089	1,089	1,089	1,089	1,089	1,089
Time & Industry Dummies	YES	YES	YES	YES	YES	YES	YES

Notes: Enh.Inn: includes process, organizational and commercialization innovations aimed at enhancing productivity.
The reference category for Employees is 0–19. Standard errors in parenthesis; (a) Number of observations used in the estimation, which differ from the total number of firms in Table 2 due to missing data in the explanatory variables. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

We present the marginal effects of the different types of innovation variables on exporting evaluated at the means, in Table 3. We find that undertaking organizational innovation, enhancing productivity innovations, and any innovation except product increase the probability of exporting by 7%, while process and commercialization innovation show an effect of 6%.

The main message seems to be that productivity-enhancing innovations positively correlate with the presence into export markets, whereas product innovation alone does not. This would indicate that innovations that reduce production costs ease entry into foreign markets.

So far, the evidence shows a positive association between innovation – any type – and the probability of exporting. When disaggregating by types, product innovation alone turned out to be non-relevant. Productivity-enhancing innovations seem to be paving the way to international markets.

We now turn to MDID. We defined the treatment only in those cases in which a firm switches from reporting no innovative activity in (*t-1*) to some form of innovation in (*t*). Firms that reported any form of innovation the first time they were observed in the sample are excluded from the analysis. We have to ensure that the treated units (new innovators) and the control units (the comparable subgroup of non-innovators) are similar with respect to every observable. Therefore, balancing tests are conducted to verify whether the average propensity score and mean of the observables are the same. The balancing propensities have in general been satisfied, as well as the common support (see Figures A1 to A6 for the different innovation variables). A balancing score test and a t-test were conducted to check the differences within bands of the propensity score between treated and untreated units (see Table A3 in the Appendix for the balancing tests for selected models).

In Table 4, we analyze the effect of innovation and different types of innovation on exporting. As above, we present the results when we consider: (A) any type of innovation, (B) product innovation, (C) process innovation, and (D) productivity-enhancing innovation, on export status. Process innovations always have positive and significant effect on the outcome variable, whereas – in two out of three set of results – also for product

Table 4. Matching and difference-in-differences results.

Matching		Outcome					
Procedure	Model	Variable	ATT	S.E.	No. Treated*	No. Controls*	Total
Nearest	(A)	Innovation	0.0103	0.0381	505	923	1428
Neighbor 5	(B)	Product Inn	0.1302***	0.0444	693	1022	1715
	(C)	Process Inn	0.0924**	0.0446	693	1022	1715
	(D)	Enh. Inn.	0.0348	0.0399	564	957	1428
Kernel	(A)	Innovation	0.0289	0.0382	527	932	1459
	(B)	Product Inn	0.1359***	0.0410	693	1022	1715
	(C)	Process Inn	0.1026**	0.0418	693	1022	1715
	(D)	Enh. Inn.	0.0380	0.0393	564	957	1521
Local Linear	(A)	Innovation	0.0088	0.0409	505	923	1428
Epan.	(B)	Product Inn	0.0735	0.0511	505	923	1428
	(C)	Process Inn	0.1268**	0.0526	693	1022	1715
	(D)	Enh. Inn.	0.0315	0.0470	564	957	1521

Note: Enh.Inn: includes process, organizational and commercialization innovations aimed at enhancing productivity. We have also used Neighbor 1 and 3 as alternatives in order to perform robustness checks and we obtained similar results, which are available upon request from the authors. Furthermore, we tested using the treatment variable after treatment with a lag and results were similar. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

innovation the results are positive and significant. However, undertaking any type of innovation (Model A) or productivity-enhancing innovation (Model D), though positive do not show a significant causal link on exports. The impact of process innovation varies according to the matching procedure from 9% to 13% while for product innovation the effect ranges from 13% to 13.6% for two of the three matching techniques used.

Thus, the causal effect of some types of innovation on exports is endorsed by MDID models, namely for process and in two out of three cases also for product innovation, which indicates that introducing this type of innovation in firms that have not done that before, does increase the probability of exporting.

Furthermore, we classify exporters according to its main destination: exporters to Mercosur countries, and exporters to the rest of the world (*row*). We perform the MDID for these two destinations and present the results in Tables 5 and 6 respectively.

While we find important effects of product and process innovation when the main destinations are Mercosur countries (nearly 12% to 13% for product innovation and around 10% for process innovation) for exports which main destination is the rest of the world we do not find causal significant effects of any type of innovation on exporting.

These results are consistent with the findings of other works for Uruguay (Peluffo, 2014, 2016), and are probably the result of the different type of goods exported to Mercosur's partners and the *row*. Exports to the *row* are mainly agricultural goods with low scope for diversification and with comparative advantage at the agricultural phase. Thus, this could explain the lack of significance of innovation for exports to the *row*. On the contrary, exports from Uruguay to Mercosur are mainly manufactured goods with more value added and with scope for diversification.

Summarizing, our findings in terms of associations show that productivity-related innovations are more relevant than product innovation in explaining export status. In terms of causality we find that the positive correlation between process and product innovation, and export status can be interpreted as causal, going from innovation to exporting, mainly for exports to Mercosur.

Table 5. Matching and difference-in-differences, outcome variable: exports to Mercosur.

Matching		Outcome					
Procedure	Model	Variable	ATT	S.E.	No. Treated*	No. Controls*	Total
Nearest	(A)	Innovation	0.0001	0.033	402	1319	1721
Neighbor 5	(B)	Product Inn	0.128***	0.035	402	1319	1721
	(C)	Process Inn	0.095***	0.034	402	1319	1721
	(D)	Enh. Inn.	0.034	0.034	402	1319	1428
Kernel	(A)	Innovation	0.016	0.032	402	1319	1721
	(B)	Product Inn	0.119***	0.032	402	1319	1721
	(C)	Process Inn	0.101***	0.032	407	1319	1726
	(D)	Enh. Inn.	0.039	0.0325	402	1319	1721
Local Linear	(A)	Innovation	0.023	0.04	402	1319	1721
Epan.	(B)	Product Inn	0.12***	0.043	402	1319	1721
	(C)	Process Inn	0.103**	0.042	402	1319	1721
	(D)	Enh. Inn.	0.0424	0.042	402	1319	1721

Note: Enh.Inn: includes process, organizational and commercialization innovations aimed at enhancing productivity. We have also used Neighbor 1 and 3 as alternatives in order to perform robustness checks and we obtained similar results, which are available upon request from the authors. Furthermore, we tested using the treatment variable after treatment with a lag and results were similar. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 6. Matching and difference-in-differences, outcome variable: exports to the rest of the world (row).

Matching		Outcome					
Procedure	Model	Variable	ATT	S.E.	No. Treated*	No. Controls*	Total
Nearest	(A)	Innovation	0.008	0.039	337	1377	1714
Neighbor 5	(B)	Product Inn	0.0403	0.0403	337	1377	1714
	(C)	Process Inn	−0.028	0.039	337	1377	1714
	(D)	Enh. Inn.	0.0203	0.0395	337	1377	1714
Kernel	(A)	Innovation	−0.0043	0.037	337	1377	1714
	(B)	Product Inn	0.0212	0.038	337	1377	1714
	(C)	Process Inn	−0.018	0.038	337	1377	1714
	(D)	Enh. Inn.	0.033	0.037	337	1377	1714
Local Linear	(A)	Innovation	−0.01	0.045	337	1377	1714
	(B)	Product Inn	0.016	0.048	337	1377	1714
Epan.	(C)	Process Inn	−0.021	0.047	337	1377	1714
	(D)	Enh. Inn.	0.027	0.047	337	1377	1714

Note: Enh.Inn: includes process, organizational and commercialization innovations aimed at enhancing productivity. We have also used Neighbor 1 and 3 as alternatives in order to perform robustness checks and we obtained similar results, which are available upon request from the authors. Furthermore, we tested using the treatment variable after treatment with a lag and results were similar. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5. Concluding remarks

This paper explores the link between innovation activities and exporting behavior among Uruguayan manufacturing firms. On a general level, innovation correlates positively with exporting as shown by logit models. Furthermore, a causal relationship can be inferred as MDID show that switching from no innovating to introducing innovations does increase the probability of exporting.

Contrary to previous research for developed countries, product innovation is not the type of innovation that better anticipates the probability of exporting (Becker & Egger, 2009; Caldera, 2010; Cassiman et al., 2010; Damijan et al., 2010). We worked under the assumption that process, organizational, and commercialization innovation, improve the way a firm produces its existing products. Our results suggest that reducing production costs may be more important than creating new products in order for Uruguayan manufacturing firms to enter and survive in the international markets. We conclude that the hypothesis that trade pushes firms to improve efficiency through productivity-enhancing innovations does hold for Uruguay, similarly to the results found by Damijan et al. (2010) for Slovenia and for Turkish manufacturing (Özçelik & Taymaz, 2004). Thus, it seems that what matters for Uruguayan firms, which are specialized in goods with low scope for vertical differentiation, is price competition.

In Uruguay, the government agency in charge of fostering export activity is Uruguay XXI. Its task is to strengthen the export capacity and competitiveness of Uruguayan companies, promote the country as an attractive destination for productive investments and promote the Uruguay Natural Country Brand in the world.[18] Uruguay XXI offers a set of tools and programs designed to support information, training and advice to the firms. Regarding to information, they generate and keep updated the information on the competitive scenario in which Uruguay carries out its export promotion activities. They spread business opportunities in new markets while developing products and services of strategic utility for exporters. They support training to promote the export culture and to encourage

[18]See https://www.uruguayxxi.gub.uy/en/.

more companies to enter the internationalization process. To these aims they organize workshops to develop export capacities and market access. They also provide personalized advice to companies and organize the participation of companies in trade fairs and visits. Since the last administration Uruguay XXI is part of the National System of Productive Transformation and Competitiveness (Transforma Uruguay) that works to promote the productive and innovative economic development of the country, created by Law in 2016.

So far, we are not aware of the existence on any scientific work evaluating the Uruguayan export-promotion system as a whole.[19] In any case, according to Uruguayan companies, Uruguay XXI has been quite active in providing support to exporters. We leave for further research an investigation of the effectiveness of Uruguay XXI in opening new markets and expanding existent ones.

The results obtained in this paper indicate that innovation policies should clearly accompany export support policies in order to facilitate the development of more efficient and motivated entrepreneurs with access to the required financial and technical support. Since our results also indicate that innovation mainly facilitates exporting to Mercosur countries, internationalization policies should be focused on improving and modernizing the necessary transport infrastructure that could allow firms to become competitive in foreign markets when they attempt to commercialize new products.

The results presented highlight the importance of bringing context into consideration when comparing results. For policy-makers and firms in Uruguay, the lesson would be to promote innovation, and mainly productivity-enhancing innovation to access and expand in international markets. Also, other policies as information and other kind of support should be provided to firms to internationalize. An avenue for further research could be to examine the effect of the recent export promotion policies on exporting for Uruguayan firms.

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No potential conflict of interest was reported by the authors.

[19]There is a work by Volpe Martincus and Carballo (2010) that analyze the policies undertaken by Uruguay XXI for the period 2000–2007 finding that the foster firms to enter into new markets.

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Appendix

Table A1. Correlation matrix between different types of innovation.

	Innovation	Product Innovation	Process Innovation	Organizational Innovation	Commercialization Innovation	Enhancing Productivity Inn.
Innovation	1					
Product Innovation	0.6367	1				
Process Innovation	0.7894	0.5365	1			
Organizational Innovation	0.5421	0.3143	0.4275	1		
Commercialization Innovation	0.4117	0.3636	0.3547	0.4632	1	
Enhancing Productivity Inn.	0.9033	0.5165	0.8739	0.6001	0.4557	1

Notes: Authors' own calculations.

Table A2. Number of observations by type of innovation.

Innovation Activity	Freq.	Percent
Non-Innovative	1,883	56
Innovative	1,502	44
Only Product	134	4
Product and Other	690	20
All but Product	644	19
All four types	190	13
Total	3,385	

Notes: Authors' own calculations.

Table A3. Balancing tests for selected models.

Treatment: Start to innovate					
Kernel Matching Outcome:		Unmatched ATT		t-test (matched)	
Variable Exports (t)	Treated	Control	% bias	t	p>|t|
Export Status	0.441	0.450	−2.000	−0.230	0.819
Lagged Employment	80.043	65.444	8.600	2.050	0.041
Lagged Share of Skilled Workers	8.820	7.311	11.300	1.540	0.124
Lagged R&D per worker	8.043	0.000	0.700	1.560	0.119
Lagged Foreign Ownership	12.076	11.064	3.300	0.380	0.701
Treatment: Start to innovate					
Local Linear Outcome: Epan Matching Exports (t)	Unmatched ATT			t-test (matched)	
Variable	Treated	Control	% bias	t	p>|t|
Export Status	0.442	0.376	13.500	1.720	0.086
Lagged Employment	79.899	72.109	4.600	1.200	0.229
Lagged Share of Skilled Workers	8.872	9.683	−6.000	−0.820	0.414
Lagged R&D per worker	9.986	0.000	0.900	1.550	0.122
Lagged Foreign Ownership	12.263	8.802	11.200	1.430	0.152

Note: We report the balancing tests for the kernel and local linear matching techniques, with exports as the outcome variable.

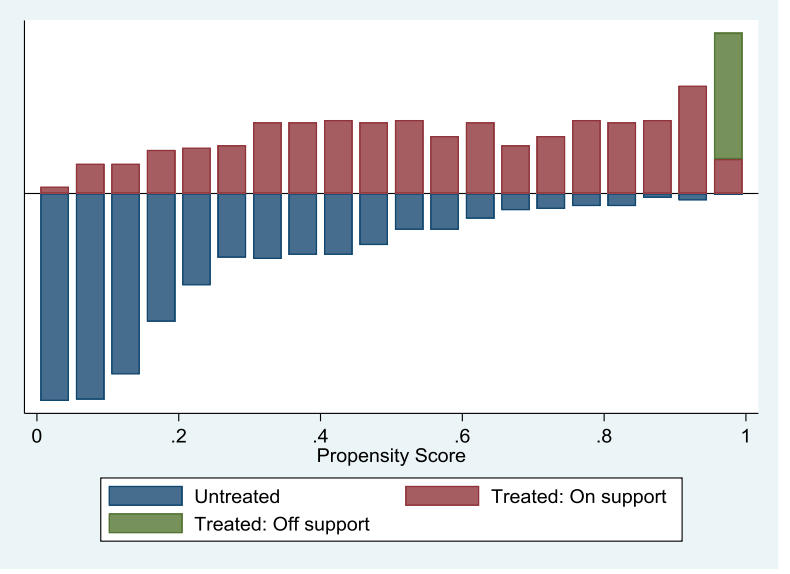

Figure A1. Common support for all innovations (kernel matching).

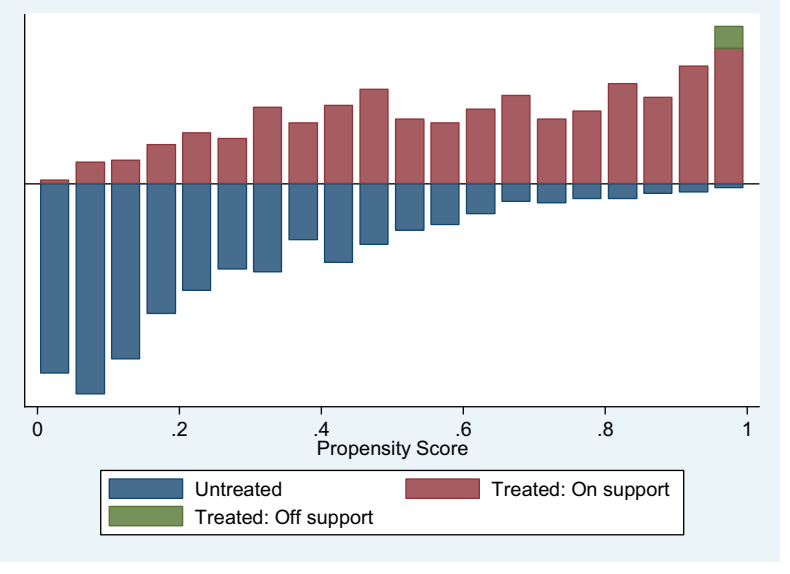

Figure A2. Common support for process innovation (kernel matching).

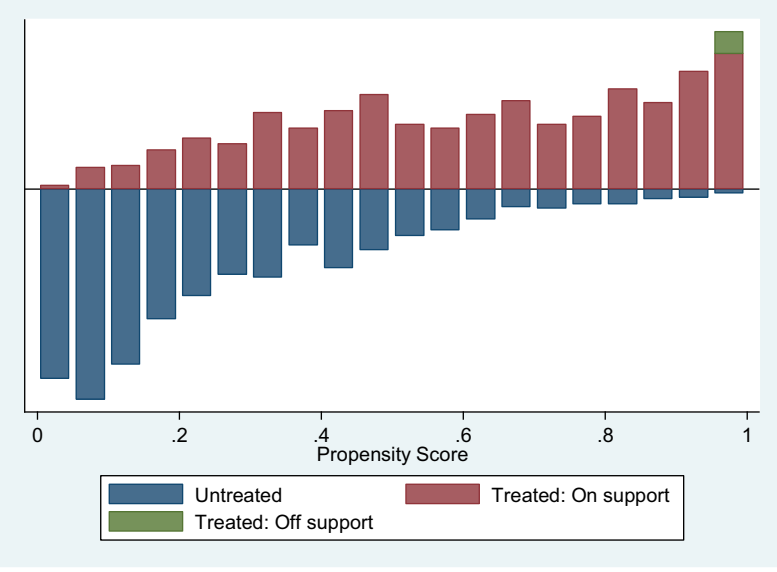

Figure A3. Common support for product innovation (kernel matching).

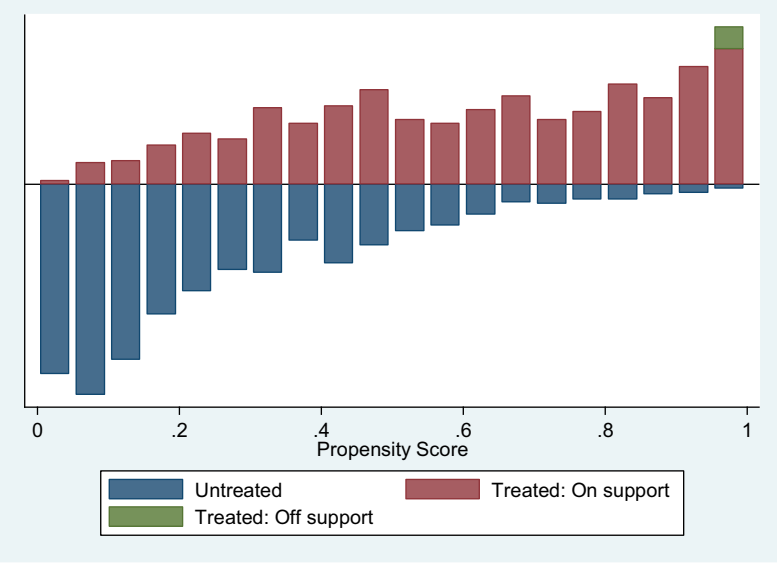

Figure A4. Common support for, all innovations (Nearest neighbor, n = 5).

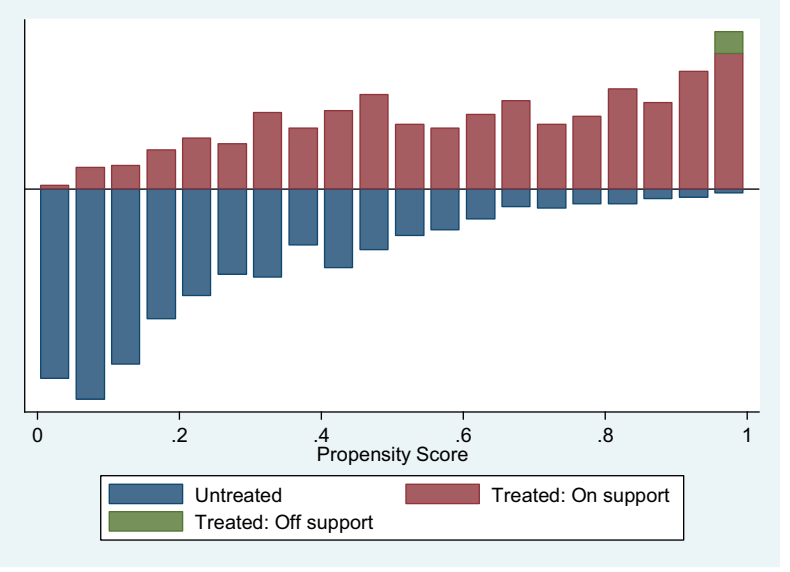

Figure A5. Common support for process innovation (Nearest neighbor, n = 5).

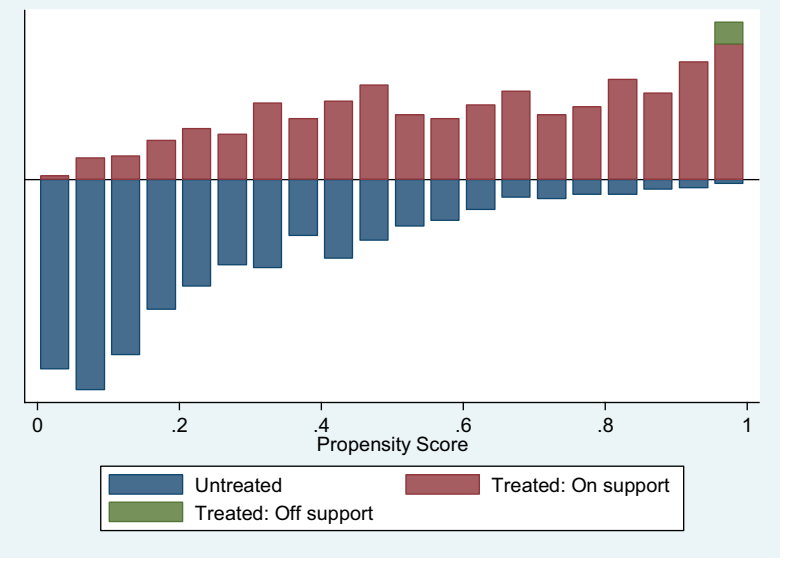

Figure A6. Common support for product innovation (Nearest neighbor, n = 5).