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New Stuff or Better Ways: What Matters to Survive International Markets?

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New Stuff or Better Ways: What Matters to Survive International Markets

Adriana Peluffo, Ernesto Silva (*)

Abstract

Innovation and export decisions are closely interlinked. Both activities contribute to firm performance in various ways: exporting provides a wider market to sell products, while innovation provides new and better products to supply those markets and/or more efficient ways to reduce costs. The connection of innovation and exporting is of major interest to developing countries aiming to achieve higher growth and wellbeing given foreign markets are both a new challenge and a source of knowledge for firms.

This study analyzes how different types of innovation affect export behavior at the firm level, as well as the consequence of exporting on further innovation activities. We use an unbalanced panel of Uruguayan manufacturing firms which provides information from 2000 to 2012. We use logistic regression and matching with difference-in-differences techniques.

Using LOGIT models, we find that previous innovation increases the probability of exporting. Unlike other studies, productivity-enhancing (or cost-reducing) innovation shows a stronger correlation than product innovation. However, using Matching and Difference-in-Differences we were not able to establish a causality link from innovation to exporting. We find no consistent evidence of an impact of previous exports on innovation activities.

Key Words: product innovation, process innovation, exporting.

JEL Classification: F14, D21, C23, O31, O33

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Nuevos Productos ó Mejores Procesos: Qué Importa para Sobrevivir en los Mercados Internacionales?

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Resumen

Innovación y exportaciones contribuyen a la performance empresarial de varias maneras: las exportaciones amplían los mercados donde se ofrecen los productos y las innovaciones permiten mejorar los bienes que se ofrecen o reducir el costo de su producción.

Este artículo analiza cómo las exportaciones de una empresa son afectadas por los diferentes tipos de innovación, así como el impacto de las exportaciones en la innovación. Utilizamos datos de panel desbalanceado para empresas manufactureras uruguayas desde el año 2000 a 2012.

Utilizando modelos LOGIT vemos que la introducción de innovaciones incrementa la probabilidad de exportar. Las innovaciones orientadas a mejorar la reducción de costos muestran una asociación más fuerte con la probabilidad de exportar, en relación a aquellas orientadas a la mejora de productos. Sin embargo, utilizando matching y diferencias dobles no hemos podido corroborar una relación causal entre ambas variables. Respecto al impacto de las exportaciones en las innovaciones, no hemos podido identificar ninguna relación significativa

Palabras clave: encuestas de innovación, innovación en producto, innovación en proceso, exportaciones, Uruguay

Código JEL: F14, D21, C23, O31, O33

1. Introduction

Innovation can come out as gift from luck, but by and large 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: innovations that produce new stuff 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 study we analyze the impact of those types of innovations on exporting behavior, as well as the impact of exporting on innovation, 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 in engage 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 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 relatively few previous studies were done. 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 has been reversed from the mid-1970s onwards.

We want to know whether innovation fosters internationalization[1] and what type 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 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. Therefore, it is also important to ponder whether or not exporting nourishes innovation in this kind of context.

Unlike other studies about this topic, we do not limit the attention to first time exporters –or first time innovators-. Using left-censored data it is not possible to clearly establish the past exporting and/or innovating history of long-standing firms. Such data limitations should not undermine the relevance of our results. Whether or not innovation helps firms enter and survive

[1] Due to data availability we have to focus only on exports.

international markets is important for business decision-making and policy recommendations. We hypothesize that innovation would increase exporting persistence and exporting would as well increase innovation persistence among Uruguayan firms.

We use an unbalanced panel of 1,678 Uruguayan manufacturing firms that were surveyed between 2000 and 2012 by the National Agency of Research and Innovation (ANII). These surveys will be 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[2].

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.

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). 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.[3]

Given that we are interested in both directions of the relationship between innovation and exports, the purpose of this study can be summarized in two questions: (1) what is more important for Uruguayan firms in order to access foreign markets, to introduce new products or to produce more efficiently?; (2) how do Uruguayan firms respond to the challenge of expanding to foreign markets, by competing in quality (new products) or in prices (efficiency)?

Each question can be associated with two hypotheses. The first set concerns the impact of innovation activity on export behavior. The hypotheses are the following:

H1: Product innovation affects 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

[2] 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 survey of mostly absent from the analyses.

[3] 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).

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.

H2: Productivity-enhancing (cost-reducing) innovations affect the exporting status of firms more than product innovation. Innovations that reduce production cost allow firms to expand sales to 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 second set of hypotheses deals with reverse causality, the impact that exporting has on the probability of developing innovation activities.

H3: Exporting mainly increases the probability of product innovation compared to other forms of innovation. Exporting firms are more likely to introduce new products to satisfy the demand of their new customers.

H4: Exporting mainly increases the probability of productivity-enhancing innovations compared to product innovation. Exporting firms respond to the competition in international markets by investing in innovation that reduce cost and improve efficiency.

The empirical strategy is designed in two steps. First, panel data LOGIT models gave us a first approximation the association between innovation and exports. Second, we use propensity score matching to explore the causal relationship between both variables.

Finally, this study suggests that productivity-enhancing innovation predict exporting behavior better than product innovation does but causality cannot be inferred. On the other hand, there is no evidence that exporting increases the likelihood of introducing any kind of innovation.

2. Literature Review

Previous studies have found a strong and positive correlation between innovation, exporting and performance (Love & Roper, 2015; Monreal-Pérez, Aragón-Sánchez, & Sánchez-Marín, 2012). 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 et al., 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 & 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: (1) self-selection; (2) conscious self-selection or anticipation; (3) 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 (Bernard & Jensen, 1999; Clerides et al., 1998; Eliasson et al., 2012; Kim, Gopinath, & Kim, 2009; Love & Roper, 2015). Some cases do provide favorable evidence to the learning-by-exporting hypothesis. Such cases include the Taiwanese electronics industry (B. Y. Aw, Roberts, & Winston, 2007); Japanese firms (Kimura & Kiyota, 2006); the United Kingdom (Girma, Greenaway, & Kneller, 2004; Greenaway & Kneller, 2007; Love & Ganotakis, 2013); Slovenia (Damijan et al., 2010; De Loecker, 2007); Spanish manufacturing firms (Hanley & Monreal-Pérez, 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, & Martínez-Ros, 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 market to increase sales or to compensate 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).

For this study we will make no assumption about the reasons behind the observed innovative behavior of firms. The first question we want to answer is what type of innovation better predicts the exporting status of Uruguayan manufacturing firms. The second question is about what type of innovation is more likely to follow the exporting behavior of those firms.

There is no consensus in the literature regarding the causal impact of innovation on exporting propensity. Many studies –probably the majority- 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). 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. Selling in a foreign market is a challenge that redefines firms. Moreover, survival in exports markets requires adaptation either through productivity gains (price) or the introduction of new products to accommodate foreign tastes (quality). Exports are expected to affect innovation by 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 & Shaver, 2005). Knowledge acquired in foreign markets allows firms to register more patents and develop new products.[4] Third, exporting firms can benefit from economies of scale that make costly innovations more profitable (Pla-Barber & Alegre, 2007; Rodil et al., 2015).

The second question formulated above points to whether or not exporting prompts up innovation –and of what type- in the context of Uruguayan manufacturing firms. It is possible that adapting to the demands of foreign customers mostly promotes the development of new products to satisfy the new clientele or that the main impact operates results from the increasing need to improve productivity through innovations in process, organization, or commercialization.

[4] Using data from Spanish firms without foreign ownership, Salomon and Shaver (2005) found that product innovation increases after exporting and peaks in two years while patent applications increase with a greater lag.

3. Empirical Strategy

We follow a two-step empirical strategy. The baseline analysis consists in the implementation of random effects LOGIT regression for panel data. Since these models do not account for selection into treatment its results cannot be given a proper causal interpretation. A more sophisticated approach follows, which consists in the application of Propensity Score Matching and Differences-in-Differences (MDiD).[5]

Methodology

Both the probability of exporting (EX=1) and the probability of reporting any type of innovation (IN=1) will be treated as a binary response outcome. When exporting is the outcome (Y=EX), then innovation is the treatment variable (T=IN), and vice versa. One or multiple treatment variables may be included in the same model depending on whether or not different types of innovation –or exporting propensity classes- are specified. There are models in which all four types of innovation are included as different binary variables and all of them can take 0 or 1 values.

Both the treatment (T=IN when Y=EX; or T=EX when Y=IN) and the vector of covariates X are presented with one-period lag. Bear in mind that for previous period we always refer to the previous survey as we do not have information on a year-by-year basis. This means that the value of the variables in the previous wave is used to predict the response in the current survey. The corresponding models look as follows (Rabe-Hesketh & Skrondal, 2008):

$$logit\{Pr(EX_{it}=1|IN_{it-3},X_{it-3})\} \equiv ln\left\{\frac{Pr(EX_{it}=1|IN_{it-3},X_{it-3})}{1-Pr(EX_{it}=1|IN_{it-3},X_{it-3})}\right\} = \beta_0+\beta_1 IN_{it-3}+\beta_2 X_{it-3}$$

$$logit\{Pr(IN_{it}=1|EX_{it-3},X_{it-3})\} \equiv ln\left\{\frac{Pr(IN_{it}=1|EX_{it-3},X_{it-3})}{1-Pr(IN_{it}=1|EX_{it-3},X_{it-3})}\right\} = \beta_0+\beta_1 EX_{it-3}+\beta_2 X_{it-3}$$

The covariates included in X differ according to the various variant of the models that were tested. Basically, these include: firm size (measured by employees and/or sales); ownership of capital (foreign capital participation dummy); absorptive capacity (share of skilled workers and/or per person spending in R&D); year dummies to control for macroeconomic shocks and other contextual changes; and industry dummies to control for industry-specific effects.[6]

[5] The initial strategy was to perform LOGIT and MDiD model. Since MDiD did not deliver significant results, we try other methodologies as well.

[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.

Two of the mentioned covariates deserve some further justification. First, 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. The presence of foreign capital indicates a certain degree of internationalization that distinguishes the firm from the nationally owned. The propensity to export among the totally or partially foreign-owned firms may be different even in the absence of any kind of innovations. Second, innovation in developing countries largely relies on absorption and adaptation of what has been done elsewhere and 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. The former is an innovation input that correlates with innovation outcomes; therefore, it is only used in descriptive statistics and is not included in econometrical models.

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 are treatments that cannot be randomly assigned. Firms that undertake any of these measures select themselves into the treatment. The remaining non-innovating or non-exporting firms cannot be used as a reliable control group because these firms are statistically different and their outcomes would have differed from that of the exporting or innovating firms even in the absence of any treatment.

To circumvent this problem, it has become normal in trade and innovation literature to rely on propensity score matching (PSM) and difference-in-differences (MDiD) in order to tackle both endogenous exporting whilst neutralizing common macroeconomic shocks (Blundell & Costa Dias, 2000; Girma, Greenaway, & Kneller, 2003; Greenaway & Kneller, 2007; Hanley & Monreal-Pérez, 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.

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 (ATET).

$$ATET = \{Pr(EX_{it} = 1 | IN_{it-3} = 1, PS(X)) - Pr(EX_{it} = 1 | IN_{it-3} = 0, PS(X))\}$$

$$ATET = \{Pr(IN_{it} = 1 | EX_{it-3} = 1, PS(X)) - Pr(IN_{it} = 1 | EX_{it-3} = 0, PS(X))\}$$

In the first stage, we use a LOGIT model to estimate the propensity score (PS) as the conditional probability of receiving treatment (T) based on the lagged values of the following variables: the total number of workers employed; the share of skilled workers; the value of sales; export

propensity or innovation activity (depending on which one is the outcome or the treatment); and the industry where the firms operated. Export propensity is defined as the ratio of the value of exports over sales.

$$PS = Pr\left(T_{t-3} = 1 \middle| X_{t-3} = \begin{Bmatrix} Workers_{t-3} + SkilledShare_{t-3} + Sales_{t-3} + ExpProp_{t-3} \\ (Innovation_{t-3}) + ForCap_{t-3} + Industry_{t-3} + Year \end{Bmatrix}\right)$$

The matching can be done with different techniques. Nearest-neighbor matches each treatment unit with one –or more- comparison unit based on score proximity. We employed this technique using 1, 3, and 5 nearest neighbors. We also used kernel and local linear matching, nonparametric estimators that use a weighted average of all nonparticipants to create the counterfactual match (Khandker, Koolwal, & Samad, 2010).

Data and Variables

We have at our disposal five rounds 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)[7]. For this study we have data corresponding to the years 2000, 2003, 2006, 2009, and 2012.

Surveys combine two inclusion criteria: (1) compulsory participation for big firms[8] 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.[9] 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.

Innovation will be presented in four 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, organizational, and commercialization. Third, three binary variables representing three possible combinations: (1) when "only product" innovation was reported, (2) when "product and other" form innovation was reported, or (3) "any but product", when any form innovation was reported except for product. Fourth, the last models include sixteen binary variables representing each one of the sixteen possible combinations between the four types of innovation.

[7] The Bogotá Manual is the adapted version for Latin America of the Oslo Manual (OECD & Eurostat, 2005).

[8] 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 higher than: $U13 million (EAII2000); USD 1 million (EAII2003); $U25 million (EAII2006); $U120 million (EAII2009). Additionally, some activities are defined as mandatory inclusion regardless of size.

[9] The exclusion of ANCAP produces important changes in the composition of the sample, as it is by far the biggest firm in the universe.

Statistical correlation between the types of innovation is high. Nevertheless, having four kinds of innovations is an asset of the data, since some previous studies have found that combining different types of innovation was crucial for exporting (Greenaway & Kneller, 2007).

There is no data on exporting behavior in the EAII 2000 Survey. From 2003 to 2012 there is information on the value of exports over previous sales. With that information we have created a binary variable "expo" indicating whether the firm has reported any sort of exporting activity. We have created a categorical variable, export propensity, in which firms are classified by the share of sales represented by exports: 0, 1 to 49 percent, 50 to 89 percent, and 90 to 100 percent.

Regarding productivity, we must state that we lack information on TFP, thus we have to rely on a very simple measure: sales per worker (also used by Ricci & Trionfetti, 2012). This variable is only referred to in descriptive statistics since both sales and workers are included in the empirical models.

The size of the firm is controlled both in terms of employment and sales. Information on employment is abridged in a categorical variable in the EAII 2000 Survey, but it is given as a continuous variable –the total number of workers- in latter surveys. Information on sales is also absent in the EAII 2000. This means that the use of this survey is limited.

Some controls were included under certain specifications. 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. This is included as a proxy for absorptive capacity, the ability of firms to incorporate new knowledge.

4. Descriptive Statistics

At the international level, the literature shows that exporting firms are not only more productive, but also bigger in terms of output and labor, are more intensive in capital, and pay higher wages (Aw & Hwang, 1995; Bernard & Jensen, 1999; Cassiman et al., 2010; Clerides et al., 1998; Delgado, Farinas, & Ruano, 2002). For what we can observe, 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 4.1).

Table 4.1: Main characteristics of firms according to exporting and innovation status (2003-2012)

	Non-Exporters		Exporters	
	Non-Innovators	Innovators	Non-Innovators	Innovators
Age of the Firm	25.1	29.3	29.9	35.9
Avg. Workers	31.5	58.5	107.8	181.4
Avg. Share of SkW	8.2	12.4	8.7	12.8
Avg. Sales	34.9	87.2	279.1	540.1
Sales/Worker	1.0	1.1	4.3	3.6
Avg. RnD per Worker	0.0	0.8	0.0	1.7
Foreign Capital	3.2%	6.3%	22.6%	28.3%
Work in FC Firms	6.0%	16.3%	39.2%	34.7%
Sales in FC Firms	12.0%	34.1%	54.1%	46.3%
Frequency (OBS)	1,365	733	518	769

Notes: Own elaboration based on survey information provided by ANII.

Considering the 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 type in the sample.

Among innovating firms, those with exporting activity invest much more heavily in R&D than those who 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, 2012). In Table 1 we see that the presence of foreign capital is clearly more preeminent among exporting firms.

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 of non-innovating exporting firms present some degree of foreign capital ownership. Nevertheless, these firms represent 39% of employment and 54.5% of sales within the category. Such dominance is explained by firms with over 90 percent of foreign owned assets and is a relatively recent phenomenon. As can be seen in Table 2, firms where foreign ownership of capital is below 90% do not weight that much neither in terms of employment nor in terms of sales.

Table 4.2: Distribution of workers and sales by degree of foreign capital ownership of firms (2003-2009)

	Non-Exporters				Exporters			
	Non-Innovators		Innovators		Non-Innovators		Innovators	
Foreign Capital (%)	**Workers**		**Workers**		**Workers**		**Workers**	
0	29.344	94,4%	26.967	85,8%	26.452	69,8%	69.527	66,8%
1-49	380	1,2%	583	1,9%	113	0,3%	2.341	2,2%
50-74	0	0,0%	0	0,0%	385	1,0%	4.963	4,8%
75-89	32	0,1%	66	0,2%	19	0,1%	695	0,7%
90-100	1.335	4,3%	3.808	12,1%	10.919	28,8%	26.534	25,5%
Total	**31.091**		**31.424**		**37.888**		**104.060**	
Foreign Capital (%)	**Sales**		**Sales**		**Sales**		**Sales**	
0	23.856	86,7%	29.612	68,2%	43.792	49,3%	166.286	56,9%
1-49	499	1,8%	959	2,2%	150	0,2%	10.050	3,4%
50-74	0	0,0%	0	0,0%	329	0,4%	14.144	4,8%
75-89	24	0,1%	127	0,3%	54	0,1%	1.416	0,5%
90-100	3.127	11,4%	12.738	29,3%	44.426	50,1%	100.526	34,4%
Total	**27.506**		**43.436**		**88.751**		**292.422**	

Notes: The Survey EAII 2012 provides only binary information on foreign capital participation. The categorical variable presented in this Table is only defined for the Surveys EAII 2003-2009.

Tables 4.3 and 4.4 show the evolution over time of the share of the working force and sales respectively, corresponding to firms with foreign capital. We can see a breaking point between 2006 and 2009 surveys. The number of employees in non-innovating exporting firms jumped from 2,243 in 2006 to 7,723 in 2009. The change in sales is even more spectacular, from 21 to 74 percent.

Table 4.3: Share of workers in foreign capital firms over time (2003-2012)

			2003	2006	2009	2012
Non-Exporters	**Non-Innovators**	Number of Firms	296	317	382	370
		Total Workers	9,086	10,415	11,590	11,909
		Workers in FC Firms	724	593	430	815
		Work FC Firms (%)	8.0%	5.7%	3.7%	6.8%
	Innovators	Number of Firms	188	164	213	168
		Total Workers	8,336	11,262	11,826	11,453
		Workers in FC Firms	851	1,840	1,766	2,536
		Work FC Firms (%)	10.2%	16.3%	14.9%	22.1%
Exporters	**Non-Innovators**	Number of Firms	111	153	128	126
		Total Workers	7,868	14,670	15,350	17,968
		Workers in FC Firms	1,467	2,243	7,726	10,462
		Work FC Firms (%)	18.6%	15.3%	50.3%	58.2%
	Innovators	Number of Firms	216	200	199	154
		Total Workers	31,441	35,566	37,053	35,421
		Workers in FC Firms	8,704	12,919	12,910	13,834
		Work FC Firms (%)	27.7%	36.3%	34.8%	39.1%

Notes: Number of firms refers to the total number of firms in any given category. FC Firms refers to firms that are totally or partially owned by foreigners.

Table 4.4: Share of sales in foreign capital firms over time (2003-2012)

			2003	2006	2009	2012
Non-Exporters	**Non-Innovators**	Number of Firms	296	317	382	370
		Total Sales	6,343	8,623	12,541	20,172
		Sales in FC Firms	1,158	1,332	1,159	2,075
		Sales FC Firms (%)	18.3%	15.5%	9.2%	10.3%
	Innovators	Number of Firms	188	164	213	168
		Total Sales	9,326	15,802	18,308	20,500
		Sales in FC Firms	2,261	5,369	6,194	7,974
		Sales FC Firms (%)	24.2%	34.0%	33.8%	38.9%
Exporters	**Non-Innovators**	Number of Firms	111	153	128	126
		Total Sales	16,492	25,533	46,726	55,840
		Sales in FC Firms	4,878	5,395	34,686	33,336
		Sales FC Firms (%)	29.6%	21.1%	74.2%	59.7%
	Innovators	Number of Firms	216	200	199	154
		Total Sales	76,641	107,781	108,000	122,929
		Sales in FC Firms	28,955	47,880	49,301	66,166
		Sales FC Firms (%)	37.8%	44.4%	45.6%	53.8%

Notes: Number of firms refers to the total number of firms in any given category. FC Firms refers to firms that are totally or partially owned by foreigners.

Table 4.5 compares the share of exporters among innovators and non-innovators; and the share of innovators among exporters and non-exporters. As expected, exporting is far more common among innovators and innovating is far more common among exporters confirming the high association between both variables.

Table 4.5: Share of exporters and innovators (2003-2012)

	Share of Exporters						Share of Innovators					
	Non-Innovators			Innovators			Non-Exporters			Exporters		
Survey	**N**	**Expo**		**N**	**Expo**		**N**	**Innova**		**N**	**Innova**	
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	55.0%
Total	**1,883**	**518**		**1,502**	**769**		**2,098**	**733**		**1,287**	**769**	

Notes: The Table displays the number of observations per survey in any given category.

In Table 4.6 we can see the number of observations by the different types of innovation and the combination of them. The majority of observations (1,996) report no innovation at all. In 1,468

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 alongside any other type of innovation, and 644 correspond to any innovation except for product. There are also 48 cases in which all three productivity-enhancing innovations were reported but not product, and 190 cases in which all four types were reported.

Table 4.6: Number of Observations by Types of Innovation

			Organization Commercialization		
Product	**Process**	NO No	NO Yes	YES No	YES Yes
NO	No	**1,996**	33	98	29
	Yes	280	24	132	**48**
YES	No	**134**	16	27	8
	Yes	286	54	109	**190**

No Innovations	1,996	1,468 Any Innovation
Only Product	134	644 Any but Product
Product and Other	690	48 All but Product

Notes: The Table displays the number of observations.

5. Empirical Results

This section will be organized as follows. We start by addressing the impact of innovation activities on exporting behavior (Hypotheses 1 and 2). The empirical analysis is based on two methods that are subsequently presented: panel data LOGIT models and propensity score matching with difference-in-differences (MDiD). The same sequence is repeated afterwards but dealing with the impact of exporting status on innovation activities (Hypotheses 3 and 4).

Table 5.1 presents a set of models that differ in how the treatment is defined and in the selection of covariates. There are certain regularities that transcend any particular specification: (1) lagged export status –either as a binary or categorical variable- increases the likelihood of current export status[10]; (2) larger firms in terms of employment and/or sales are more likely to export; (3) the share of skilled workers has no significant impact.

The relationship between lagged innovation and exporting status depends on how the treatment is defined. When all kinds of innovations are jointly represented by a single binary variable, lagged innovation has a positive and significant impact on the probability of exporting. When the four types are included as separate binary variables, then product innovation has no significant impact. Meanwhile, only organizational innovation appears to have a significant effect. The former specification is prone to multicollinearity since there is high correlation between the different types of innovations. To avoid such problems, Models 5 and 6 present mutually exclusive innovation categories. Results provide support for Hypothesis 2: the combination of any type of innovation –other than product- is clearly the strongest predictor of exporting status.

[10] This finding is common in previous literature and it is often interpreted as evidence of sunk costs for exporting (Faustino & Matos, 2015; Roberts & Tybout, 1997).

Table 5.1: Innovation and Export Activity (LOGIT)

Dependent Variable: Export Activity (t)									
Covariates	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6	(7) Model 7	(8) Model 8	(10) Model 10
Export (t-3)		3.609***	3.586***		3.610***		3.626***		-1.086***
		(0.157)	(0.166)		(0.168)		(0.169)		(0.341)
Export 1-49% (t-3)				3.174***		3.202***		3.212***	
				(0.173)		(0.175)		(0.176)	
Export 50-89% (t-3)				4.672***		4.686***		4.731***	
				(0.392)		(0.393)		(0.396)	
Export 90-100% (t-3)				5.446***		5.476***		5.503***	
				(0.500)		(0.502)		(0.501)	
Innovation (t-3)	0.627**	0.377**	0.311*	0.345**					0.0389
	(0.277)	(0.160)	(0.168)	(0.172)					(0.391)
Only Product (t-3)					-0.0245	0.125			
					(0.380)	(0.367)			
Product and Other (t-3)					0.232	0.250			
					(0.206)	(0.209)			
Any but Product (t-3)					0.439**	0.471**			
					(0.206)	(0.211)			
Product Inn. (t-3)							-0.182	-0.149	
							(0.204)	(0.205)	
Process Inn. (t-3)							0.220	0.150	
							(0.202)	(0.206)	
Org. Inn. (t-3)							0.372*	0.428*	
							(0.222)	(0.224)	
Comm. Inn. (t-3)							0.0984	0.180	
							(0.261)	(0.259)	
Employees 20-100 (t-3)	1.098**	0.438*	0.422*	0.612**	0.428*	0.622**	0.425*	0.617**	
	(0.473)	(0.243)	(0.256)	(0.272)	(0.256)	(0.272)	(0.256)	(0.272)	
Employees100+ (t-3)	1.594**	0.548*	0.580*	0.760**	0.609*	0.790**	0.589*	0.769**	
	(0.641)	(0.318)	(0.344)	(0.362)	(0.344)	(0.363)	(0.345)	(0.364)	
Share of Skilled (t-3)			0.0110	0.00915	0.0115	0.00966	0.0111	0.00917	0.00362
			(0.00704)	(0.00738)	(0.00706)	(0.00741)	(0.00706)	(0.00741)	(0.0258)
Log of Sales (t-3)	1.686***	0.363***	0.412***	0.349***	0.404***	0.342***	0.401***	0.340***	0.417
	(0.174)	(0.0710)	(0.0795)	(0.0838)	(0.0799)	(0.0842)	(0.0802)	(0.0844)	(0.354)
Foreign Capital (t-3)	1.783***	0.327	0.364	0.213	0.344	0.191	0.333	0.161	0.672
	(0.516)	(0.241)	(0.250)	(0.268)	(0.251)	(0.268)	(0.251)	(0.270)	(0.863)
Constant	-19.88***	-6.376***	-6.999***	-6.479***	-6.936***	-6.419***	-6.925***	-6.435***	
	(1.808)	(0.672)	(0.775)	(0.804)	(0.778)	(0.806)	(0.781)	(0.809)	
Observations	1,885	1,885	1,879	1,879	1,879	1,879	1,879	1,879	219
Ids	1,091	1,091	1,089	1,089	1,089	1,089	1,089	1,089	77
Year	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry			YES	YES	YES	YES	YES	YES	
Fixed Effects									YES
Akaike Criterion AIC	1.556	1.195	1.196	1.157	1.198	1.160	1.197	1.157	159
Bayesian Criterion BIC	1.606	1.250	1.362	1.334	1.375	1.348	1.380	1.351	186

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: There is a three-year gap between observations, therefore t-3 represent one observation lag. The reference category for Employees is 0-19. The last column presents a fixed effects model. This specification considerably reduced the number of firms and observations. The following analysis is based on the random effect models.

Table 5.2: Interaction between innovations (LOGIT)

Dependent Variable: Export Activity (t)			
Covariates	(1) Model 1	(2) Model 2	(3) Model 3
Export (t-3)		3.658***	3.661***
		(0.171)	(0.172)
Only Commercialization	-0.321	-0.00141	-0.0409
	(1.395)	(0.774)	(0.784)
Only Orgnization	1.865**	0.739	0.685
	(0.847)	(0.457)	(0.461)
Organization and Commericalization	2.572*	0.335	0.315
	(1.363)	(0.702)	(0.710)
Only Product	1.560**	0.0144	-0.0223
	(0.675)	(0.383)	(0.382)
Product and Commercialization	2.534	0.0659	0.00644
	(1.731)	(1.042)	(1.057)
Product and Organization	1.924	0.0670	0.0121
	(1.265)	(0.883)	(0.883)
Product Organization Commercialization	1.217	-0.889	-0.934
	(3.388)	(1.194)	(1.198)
Only Process	1.313***	0.198	0.188
	(0.499)	(0.293)	(0.294)
Process and Commercialization	3.448*	0.588	0.535
	(1.950)	(1.059)	(1.055)
Process and Organization	1.499**	0.482	0.452
	(0.590)	(0.353)	(0.354)
Process Organization Comercialization	5.241***	1.231**	1.216**
	(1.127)	(0.481)	(0.484)
Product and Process	1.943***	0.135	0.100
	(0.515)	(0.279)	(0.281)
Product Process Commercalization	1.647	0.261	0.200
	(1.002)	(0.625)	(0.631)
Product Process Organization	2.248***	0.543	0.493
	(0.665)	(0.398)	(0.398)
All Innovations	2.593***	0.471	0.413
	(0.573)	(0.326)	(0.327)

Notes: Each category represents a combination of different types of innovation. "No innovation" is the reference. "All innovations" means that all 4 types were reported in the survey. Model (1) neither includes lagged exports nor any covariate other than the innovation terms. Model (2) adds number of workers, sales, and foreign capital. On top of that, Model (3) includes the share of skilled workers (not shown).

An even more detailed categorical variable is presented in Table 5.2 where all 16 combinations of the four types of innovations are presented as mutually exclusive categories ranging from "no innovations" to "all types of innovation". Once again, it seems that Hypothesis 2 is better suited

to the results. The combination of process, organization, and commercialization innovation is the only category with a strong positive coefficient that is statistically different from zero in all specifications.

So far, the evidence shows a high association between innovation –any type- and the probability of exporting. When disaggregated by types, product innovation turned out to be the less relevant form. Productivity-enhancing innovations seem to be paving the way to international markets. To take a step further, we now turn to propensity score matching and differences-in-differences (MDiD).

Here we defined the treatment only in those cases in which a firm switches from reporting no innovative (t-6) activity to some form of innovation (t-3). Firms that reported any form of innovation the first time they were observed were excluded.

Table 5.3: The impact of Innovation on Export Behavior using MDiD

Average Treatment Effect on the Treated (ATET)					
Treatment: Innovation (t-3) Outcome: Exports (t)					
Matching Method	Treated	Control	Difference	S.E.	T-Statistic
Nearest Neighbour (1)	0.40	0.36	0.04	0.08	0.53
Nearest Neighbour (3)	0.40	0.33	0.07	0.06	1.08
Nearest Neighbour (5)	0.40	0.33	0.07	0.06	1.15
Kernel Matching (Epan)	0.39	0.35	0.04	0.06	0.75
Local Linear Reg (Epan)	0.40	0.36	0.04	0.08	0.49

Notes: Only firms that went from no innovation to some form of innovation as considered as treated.

As we see in Table 5.3, the transition from no innovation to innovation does not have a causal effect on the probability of exporting. By eliminating firms that reported innovations in the first observation, the database is reduced from 1,678 firms to 920. The firms that are excluded are on average bigger both in terms of sales and employees, and are also more likely to be exporters. Among the firms that remain in the dataset, we observe 166 cases of innovation: 40 percent of those who introduce any form of innovation reported exports in the following period, against 23 percent of those who did not produce any innovation. Nevertheless, the causal effect is not endorsed by MDiD models which indicates that introducing innovations in firms that have not done that before does not increase the probability of exporting.

Export Propensity

Former models analyzed exports as a binary outcome: firms either exports or not. However, the exporting performance can also be measured as export propensity or intensity: the ratio of exports over total sales. Panel data regressions show no significant relationship between innovation –either defined as a binary variable or as investment in R&D over sales- and export propensity. Table 5.4 shows the results. The models 1-3 were ran with random effects models, the models 4-6 with fixed effects.

Table 5.4: Innovation and Export Intensity (XTREG)

Dependent Variable:	Export Intensity (t): Exports/Sales					
Covariates	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
Innovation (t-3)	1.354			0.160		
	(0.927)			(1.012)		
RnD/Sales (t-3)			0.139			0.0785
			(0.168)			(0.198)
Only Product (t-3)		3.093			2.951	
		(2.009)			(2.141)	
Product and Other (t-3)		2.451**			1.447	
		(1.135)			(1.240)	
Any but Product (t-3)		0.436			-0.729	
		(1.058)			(1.124)	
Employees 20-300 (t-3)	7.021***	6.952***	7.235***	6.590***	6.351**	6.596***
	(1.503)	(1.502)	(1.495)	(2.479)	(2.475)	(2.474)
Employees100+ (t-3)	16.39***	16.20***	16.80***	8.091***	7.735**	8.129***
	(1.925)	(1.924)	(1.902)	(3.094)	(3.090)	(3.083)
Share of Skilled (t-3)	0.0118	0.0107	0.0194	-0.0640	-0.0612	-0.0618
	(0.0423)	(0.0423)	(0.0420)	(0.0541)	(0.0541)	(0.0539)
Log (Sales/Worker) (t-3)	5.790***	5.746***	5.872***	-0.376	-0.454	-0.370
	(0.599)	(0.599)	(0.596)	(0.884)	(0.883)	(0.880)
Foreign Capital (t-3)	12.70***	12.71***	12.64***	1.588	1.703	1.565
	(1.900)	(1.900)	(1.900)	(2.466)	(2.465)	(2.464)
Constant	-29.14***	-28.91***	-29.32***	14.90*	17.22**	16.82**
	(4.134)	(4.133)	(4.132)	(8.051)	(7.900)	(7.909)
Observations	1,885	1,885	1,885	1,885	1,885	1,885
R2				0.022	0.028	0.022
Ids	1,091	1,091	1,091	1,091	1,091	1,091
Year	YES	YES	YES	YES	YES	YES
Industry	YES	YES	YES	YES	YES	YES
Fixed Effects				YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: Productivity is included as sales per worker.

It is interesting to see that when innovation is presented in categories, only the combination of product and other types of innovation is significantly related to higher export intensity (the effect disappears when fixed effects is used instead of RE). This suggest that innovation overall does not increase export propensity, but only when new products and new methods were previously introduced we can observe higher exports.

Alternative specifications were also considered. Such as defining the outcome as the first difference in export propensity:

$$Y = Exp_t - Exp_{t-3}$$

...or as the rate of exports growth between observations:

$$Y = ln(Exp_t/Exp_{t-3})$$

None of these models produced significant results. Nonetheless, given the non-negative nature of the outcome variable and the fact that around 60 per 100 of the observations report zero exports, we also implemented TOBIT models with export intensity as the dependent variable (see Table 5.5).

(Table 5.5) Innovation and Export Intensity (TOBIT)

Dependent Variable:	Export Depth (t): Exports/Sales					
Covariates	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(8) Model 5	(10) Model 6
Innovation (t-3)	7.608***	7.608**				
	(2.949)	(3.263)				
RnD/Sales (t-3)					0.392*	0.392**
					(0.210)	(0.176)
Only Product (t-3)			0.566	0.566		
			(6.852)	(7.069)		
Product and Other (t-3)			9.911***	9.911***		
			(3.470)	(3.735)		
Any but Product (t-3)			6.245*	6.245		
			(3.542)	(3.881)		
Employees 20-300 (t-3)	29.55***	29.55***	29.51***	29.51***	31.08***	31.08***
	(4.335)	(5.042)	(4.328)	(5.033)	(4.277)	(4.954)
Employees100+ (t-3)	58.62***	58.62***	58.26***	58.26***	61.80***	61.80***
	(4.920)	(5.829)	(4.918)	(5.818)	(4.760)	(5.566)
Share of Skilled (t-3)	0.110	0.110	0.0989	0.0989	0.145	0.145
	(0.121)	(0.145)	(0.121)	(0.145)	(0.119)	(0.143)
Log (Sales/Worker)	20.56***	20.56***	20.56***	20.56***	20.73***	20.73***
	(1.444)	(2.014)	(1.444)	(2.015)	(1.438)	(2.001)
Foreign Capital (t-3)	23.16***	23.16***	23.02***	23.02***	23.01***	23.01***
	(3.757)	(5.076)	(3.756)	(5.062)	(3.754)	(5.060)
Constant	-188.6***	-188.6***	-188.6***	-188.6***	-187.6***	-187.6***
	(11.15)	(14.14)	(11.16)	(14.14)	(11.14)	(14.10)
Observations	1,885	1,885	1,885	1,885	1,885	1,885
Year	YES	YES	YES	YES	YES	YES
Industry	YES	YES	YES	YES	YES	YES
Cluster (Firm)		YES		YES		YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: Productivity is included as sales per worker.

Table 5.5 shows that innovation has predictive power over export propensity. Again it is the combination of product and other types what is significant.

Finally, if we instrument innovation status using lagged innovation as the instrument we get some significant results when two lags are included as instruments (Table 5.6). For this, we used the command ivreg2 (Baum, Schaffer, & Stillman, 2003).

(Table 5.6) Innovation and Export Intensity (IVREG2)

Dependent Variable:	Export Depth (t): Exports/Sales			
Covariates	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4
Innovation	7.524	12.73*	11.97	21.91**
	(6.399)	(7.597)	(8.684)	(9.942)
Employees 20-300	-8.134***	-0.213	-8.467**	-3.682
	(2.175)	(2.539)	(3.435)	(4.021)
Employees100+	-4.373	13.04***	-5.812	5.442
	(4.087)	(4.550)	(5.477)	(6.520)
Share of Skilled		-0.0561		-0.146
		(0.0778)		(0.102)
Log of Sales	7.027***		6.352***	
	(1.040)		(1.425)	
Log (Sales/Worker)		8.712***		8.167***
		(1.251)		(1.713)
Foreign Capital	16.22***	15.11***	17.19***	17.11***
	(3.381)	(3.705)	(3.878)	(4.157)
Constant	-56.47***	-51.98***	-51.32***	-47.39***
	(8.426)	(7.145)	(12.71)	(10.86)
Observations	2,446	1,721	1,294	895
R-squared	0.311	0.291	0.267	0.211
Year	YES	YES	YES	YES
Industry	YES	YES	YES	YES
Cluster (Firm)	YES	YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: In models 1 and 2 IV: Innovation=Innovation (t-3); in models 3 and 4 IV: Innovation = Innovation (t-3) + Innovation (t-6). All models are clustered by firm.

We have not obtained significant results when different types of innovation were included in the model (not shown).[11]

Exporting on Innovation

The remaining part of this section deals with the reverse of the relationship, how previous exporting status affects the probability of engaging innovation activities. The empirical strategy also consists in LOGIT and MDiD models.

[11] Results are available upon request.

(Table 5.7) Export Behavior and Innovation (LOGIT)

Dependent Variable:	Innovation Activity (t)								
Covariates	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6	(7) Model 7	(8) Model 8	(10) Model 10
Export (t-3)	0.0278	-0.0373	-0.00367		-0.0354		-0.0255		-0.450
	(0.168)	(0.122)	(0.128)		(0.129)		(0.135)		(0.392)
Export 1-49% (t-3)				0.161		0.129		0.129	
				(0.139)		(0.140)		(0.145)	
Export 50-89% (t-3)				-0.157		-0.169		-0.147	
				(0.207)		(0.208)		(0.215)	
Export 90-100% (t-3)				-0.607***		-0.643***		-0.614***	
				(0.215)		(0.216)		(0.223)	
Innovation (t-3)		1.238***	1.104***	1.101***					-1.739***
		(0.107)	(0.111)	(0.111)					(0.256)
Only Product (t-3)					1.047***	0.999***			
					(0.258)	(0.261)			
Product and Other (t-3)					1.390***	1.391***			
					(0.139)	(0.139)			
Any but Product (t-3)					0.845***	0.846***			
					(0.135)	(0.136)			
Product Inn. (t-3)							0.615***	0.608***	
							(0.143)	(0.142)	
Process Inn. (t-3)							0.452***	0.482***	
							(0.142)	(0.141)	
Org. Inn. (t-3)							0.383**	0.367**	
							(0.154)	(0.153)	
Comm. Inn. (t-3)							0.383**	0.363*	
							(0.186)	(0.185)	
Employees 20-100 (t-3)	0.438**	0.251	0.308*	0.243	0.308*	0.246	0.336**	0.275	
	(0.208)	(0.157)	(0.164)	(0.165)	(0.164)	(0.166)	(0.170)	(0.169)	
Employees100+ (t-3)	0.694**	0.424*	0.641***	0.581**	0.609***	0.550**	0.634***	0.571**	
	(0.296)	(0.218)	(0.232)	(0.233)	(0.233)	(0.235)	(0.244)	(0.242)	
Share of Skilled (t-3)			0.00768*	0.00802*	0.00648	0.00683	0.00664	0.00702	-0.000704
			(0.00462)	(0.00463)	(0.00466)	(0.00468)	(0.00484)	(0.00479)	(0.0137)
Log of Sales (t-3)	0.432***	0.265***	0.251***	0.282***	0.255***	0.284***	0.264***	0.288***	0.161
	(0.0672)	(0.0480)	(0.0509)	(0.0520)	(0.0512)	(0.0523)	(0.0551)	(0.0556)	(0.195)
Foreing Capital (t-3)	0.256	0.132	0.0916	0.198	0.108	0.210	0.119	0.216	0.447
	(0.233)	(0.166)	(0.173)	(0.176)	(0.174)	(0.177)	(0.182)	(0.183)	(0.615)
Constant	-5.159***	-3.851***	-3.936***	-4.204***	-3.959***	-4.211***	-4.090***	-4.277***	
	(0.612)	(0.430)	(0.472)	(0.482)	(0.476)	(0.484)	(0.520)	(0.523)	
Observations	1,885	1,885	1,881	1,881	1,881	1,881	1,881	1,881	586
Ids	1,091	1,091	1,089	1,089	1,089	1,089	1,089	1,089	208
Year	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry			YES	YES	YES	YES	YES	YES	
Fixed Effects									YES
Akaike Criterion AIC	2,285	2,213	2,201	2,192	2,191	2,182	2,189	2,181	361
Bayesian Criterion BIC	2,334	2,268	2,367	2,369	2,369	2,370	2,371	2,375	396

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: Lagged innovation is included as a control in all models except Model 1. The reference category for number of employees is 1-19. Model 10 is Fixed Effects.

Random effects LOGIT models (Table 5.7) reveal no incidence of previous exporting status on current innovation activities regardless of specification. This can be said of all types of innovation separately considered as well (Table 5.8). There are some curious results when we include export propensity, defined as a categorical variable, instead of an export status dummy (Models 4, 6, and 8). This change produced a surprising negative association between high export propensity (90-100%) and innovation activity. Negative coefficients appear in different specifications and are significant at the 0.01 level. These results are robust to other specifications not reported here. As an interesting hint, we observed that despite being negative, the coefficient of high export propensity is not significant when only firms with foreign capital are included. Restricting the sample to locally owned firms produces negative and highly significant results. Despite exporters being more innovative than non-exporting firms, among exporters, high propensity correlates with less innovation and not more, and this is mainly explained by local firms.

Table 5.8 reproduces the analysis but this time the dependent variable is defined as the different types of innovation. Exporting behavior does not have a significant impact on the probability of undertaking any type of innovation except for product innovation. Firms that export 1-49 percent of sales are more likely to report product innovation compared to non-exporters. However, firms with high export propensity are actually less likely to report any product innovation. This confirms the aforementioned phenomenon; high export propensity is associated with less innovation, more specifically, less product innovation. Yet low export propensity seems to increase the probability of introducing new products. Perhaps these are the firms that mostly need to diversify in order to survive international markets, while high export propensity is most likely to occur among firms specialized in the production of primary goods that are less suited to be substantially improved by technological changes. [12]

[12] Trade with Free Trade Zones could be related with these findings. Commodities that are sold as inputs to firms operating in FTZs are considered exports. For more information about Uruguayan FTZs: http://www.uruguayxxi.gub.uy/guide/descargas/Zonas%20Francas%20-%20Uruguay%20XXI.pdf

Table 5.8: Export Activity and Types of Innovation (LOGIT)

Dependent Variable:	Product Innovation		Process Innovation		Organization Innovation		Commercialization Innovation	
Export (t-3)	0.238		0.0764		-0.0367		0.118	
	(0.182)		(0.138)		(0.166)		(0.219)	
Export 1-49% (t-3)		0.334**		0.0563		-0.0503		0.165
		(0.160)		(0.143)		(0.171)		(0.219)
Export 50-89% (t-3)		-0.179		0.180		0.00315		-0.0701
		(0.240)		(0.208)		(0.241)		(0.313)
Export 90-100% (t-3)		-0.450*		-0.314		-0.185		-0.335
		(0.263)		(0.223)		(0.272)		(0.365)
Innovation (t-3)	0.793***		1.062***		0.642***		0.481**	
	(0.166)		(0.128)		(0.156)		(0.206)	
Product Inn. (t-3)		0.951***		0.643***		0.255		0.346*
		(0.178)		(0.136)		(0.163)		(0.208)
Process Inn. (t-3)		0.116		0.607***		0.0501		-0.0466
		(0.157)		(0.136)		(0.170)		(0.220)
Org. Inn. (t-3)		0.162		0.129		0.351**		0.262
		(0.165)		(0.148)		(0.171)		(0.225)
Comm. Inn. (t-3)		0.229		0.315*		0.675***		0.467**
		(0.185)		(0.172)		(0.185)		(0.237)
Employees 20-100 (t-3)	0.309	0.225	0.405**	0.401**	0.361	0.383*	-0.375	-0.410
	(0.243)	(0.212)	(0.192)	(0.188)	(0.234)	(0.229)	(0.293)	(0.287)
Employees100+ (t-3)	0.809**	0.633**	0.691***	0.606**	0.758**	0.701**	0.220	0.0774
	(0.331)	(0.285)	(0.259)	(0.251)	(0.310)	(0.303)	(0.383)	(0.372)
Share of Skilled (t-3)	0.0142**	0.0118**	0.00802	0.00686	0.00766	0.00606	0.000753	-0.000378
	(0.00593)	(0.00515)	(0.00494)	(0.00483)	(0.00575)	(0.00561)	(0.00784)	(0.00765)
Log of Sales (t-3)	0.124*	0.136**	0.224***	0.226***	0.0995	0.0945	0.165**	0.195**
	(0.0734)	(0.0634)	(0.0563)	(0.0549)	(0.0654)	(0.0647)	(0.0841)	(0.0841)
Foreing Capital (t-3)	0.0106	0.126	0.169	0.216	-0.124	-0.0978	-0.0857	-0.0244
	(0.228)	(0.190)	(0.175)	(0.171)	(0.203)	(0.198)	(0.249)	(0.241)
Constant	-4.170***	-3.929***	-4.357***	-4.340***	-3.380***	-3.343***	-4.274***	-4.467***
	(0.708)	(0.610)	(0.541)	(0.516)	(0.620)	(0.602)	(0.803)	(0.787)
Observations	1,881	1,881	1,881	1,881	1,881	1,881	1,830	1,830
Ids	1,089	1,089	1,089	1,089	1,089	1,089	1,061	1,061
Year	YES	YES	YES	YES	YES	YES	YES	YES
Industry	YES	YES	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: Covariates in rows, dependent variable in columns. All models are random effects panel data LOGIT regressions.

Besides the ambiguous relationship between export propensity and product innovation, the previous models show no association between exporting behavior and innovation. Based on those results both Hypothesis 3 (exporting increases product innovation) and Hypothesis 4 (exporting increases cost-saving innovations) should be rejected.

MDiD models show that firms that started exporting did not increase their innovation activities. This result holds regardless of matching technique (see Table 5.9).

Table 5.9: The impact of Export Behavior on Innovation using MDiD

Average Treatment Effect on the Treated (ATET) Treatment: Exports (t-3) Outcome: Innovation (t)					
Matching Method	Treated	Control	Difference	S.E.	T-Statistic
Nearest Neighbour (1)	0.54	0.54	0.00	0.11	0.00
Nearest Neighbour (3)	0.54	0.56	-0.01	0.09	-0.16
Nearest Neighbour (5)	0.54	0.57	-0.03	0.09	-0.34
Kernel Matching (Epan)	0.56	0.54	0.02	0.08	0.21
Local Linear Reg (Epan)	0.54	0.55	-0.01	0.11	-0.08

Notes: Information on balancing test in Appendix.

The lack of significant results provides further evidence for the inexistence of a causal link between previous exporting status and current innovation. If any, the controls present a slightly higher incidence of innovation than the treated. Overall, exporting does not push for innovation among Uruguayan manufacturing firms.

Table 5.10: The impact of Export Behavior on the different types of Innovation using PSM

Type of Innovation (Kernel Matching)	Treated	Control	Difference	S.E.	T-Statistic
Product Inovation	0.24	0.24	0.01	0.07	0.10
Process Innovation	0.47	0.38	0.08	0.08	1.03
Organization Innovation	0.24	0.19	0.05	0.07	0.78
Commerce Innovation	0.04	0.05	-0.01	0.04	-0.23

Notes: Here the different types of innovation are not the treatment, but the outcome. The treatment is always defined as the export dummy for the previous period.

Table 5.10 presents kernel matching models using exporting status as the treatment and the different types of innovation as outcomes. Consistent with previous results, we see that exporting does not seem to increase innovativeness –in any of its forms- among Uruguayan Manufacturing firms.

6. Concluding Remarks

This paper explored the double link between innovation activities and exporting behavior among Uruguayan manufacturing firms. On a general level, lagged innovation correlates favorably with exporting as shown by LOGIT and TOBIT models, but a causal relationship cannot be inferred as MDiD show that introducing innovations does not increase the probability of exporting. On the other hand, we found no consistent evidence of a positive impact of previous exporting status on current innovation activities.

Contrary to previous research done in 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 already existing products. Our results suggest that reducing production costs is at least as important as generating new products in order for Uruguayan manufacturing firms to enter and survive in the international market. Similar results were obtained for Turkish manufacturing (Özçelik & Taymaz, 2004).

We fail to find any consistent link from exporting status to innovation. Most models provide results that lack statistical significance. LOGIT models revealed a positive association between low export propensity and innovation, but a negative one for high export propensity.

The idea that trade pushes firms to improve efficiency through productivity-enhancing innovations does not hold for Uruguay, unlike what Damijan et al. (2010) found in Slovenia.

The results we have 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 the combination of both product and productivity-enhancing innovation in order to success in international markets.

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8. Appendix

Table 8.1: Balancing Test for Table 5.3

Treatment: 1st. Reported Innovation	Outcome: Export (t)	Treated	Control	Difference	S.E.
Nearest Neighbour (3)	Unmatched	0.40	0.20	0.20	0.05
	ATT	0.40	0.33	0.07	0.06
	ATU	0.20	0.23	0.03	.
	ATE			0.04	.
Variable	**Treated**	**Control**	**%bias**	**t**	**p>t**
workers (t-3)	74.20	69.64	5.10	0.30	0.77
skilled workers (t-3)	10.18	10.30	-0.90	-0.05	0.96
sales (t-3)	10.74	10.71	2.40	0.17	0.87
export prop (t-3)	20.15	20.91	-2.50	-0.16	0.88
foreign cap (t-3)	9.93	11.54	-6.70	-0.38	0.70
Kernel Matching (Epan)	Unmatched	0.40	0.20	0.20	0.05
	ATT	0.39	0.35	0.04	0.06
	ATU	0.20	0.21	0.01	.
	ATE			0.02	.
Variable	**Treated**	**Control**	**%bias**	**t**	**p>t**
workers (t-3)	73.52	67.98	6.20	0.37	0.71
skilled workers (t-3)	9.82	9.90	-0.60	-0.04	0.97
sales (t-3)	10.72	10.67	3.40	0.23	0.82
export prop (t-3)	20.23	20.14	0.30	0.02	0.99
foreign cap (t-3)	9.02	8.57	1.90	0.12	0.91
Local Linear Regression (Epan)	Unmatched	0.20	0.20	0.05	4.47
	ATT	0.40	0.36	0.04	0.08
	ATU	0.20	0.24	0.04	.
	ATE			0.04	.
Variable	**Treated**	**Control**	**%bias**	**t**	**p>t**
workers (t-3)	74.20	78.81	-5.10	-0.28	0.78
skilled workers (t-3)	10.18	11.60	-10.70	-0.57	0.57
sales (t-3)	10.74	10.76	-0.90	-0.06	0.95
export prop (t-3)	20.15	24.85	-15.20	-0.93	0.35
foreign cap (t-3)	9.93	10.85	-3.80	-0.22	0.83

Notes: Selected Models.

Table 8.2: Balancing Test for Table 5.9

Treatment: 1st Time Exports (t-3)	Outcome: Innovation (t)	Treated	Control	Difference	S.E.
Nearest Neighbour (3)	Unmatched	0.54	0.35	0.19	0.07
	ATT	0.54	0.56	-0.01	0.09
	ATU	0.35	0.22	-0.13	.
	ATE			-0.12	.

Variable	**Treated**	**Control**	**%bias**	**t**	**p>t**
workers (t-3)	100.57	91.70	9.20	0.39	0.70
pro workers (t-3)	9.57	9.86	-2.80	-0.17	0.87
sales (t-3)	11.45	11.52	-5.90	-0.32	0.75
foreign cap (t-3)	12.17	10.57	6.40	0.25	0.81

Kernel Matching (Epan)	Unmatched	0.54	0.35	0.19	0.07
	ATT	0.56	0.54	0.02	0.08
	ATU	0.35	0.26	-0.09	.
	ATE			-0.08	.

Variable	**Treated**	**Control**	**%bias**	**t**	**p>t**
workers (t-3)	99.69	90.30	9.70	0.40	0.69
pro workers (t-3)	9.60	10.11	-4.80	-0.26	0.79
sales (t-3)	11.40	11.31	7.20	0.36	0.72
foreign cap (t-3)	12.44	11.54	3.60	0.13	0.89

Local Linear Regression (Epan)	Unmatched	0.54	0.35	0.19	0.07
	ATT	0.54	0.55	-0.01	0.11
	ATU	0.35	0.19	-0.16	.
	ATE			-0.15	.

Variable	**Treated**	**Control**	**%bias**	**t**	**p>t**
workers (t-3)	100.57	111.89	-11.70	-0.46	0.65
pro workers (t-3)	9.57	8.74	7.70	0.52	0.61
sales (t-3)	11.45	11.61	-12.60	-0.68	0.50
foreign cap (t-3)	12.17	8.65	14.00	0.56	0.58

Notes: Selected Models.

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