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ARTICLE

The contribution of innovation effort to exporter performance: an analysis of Mercosur countries

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Abstract

The aim of this paper was to gauge whether innovation effort positively affects the probability of exporting for manufacturing companies in Mercosur countries: Argentina, Brazil, Paraguay and Uruguay. To this end, three econometric models of dichotomous response were applied to cross-sectional data: probit; bivariate probit, to correct the problem of endogeneity; and the Heckman selection model, for the correction of sample selection bias. We used firm-level data from the World Bank's Enterprise Surveys database. The results showed that innovation positively affects the likelihood of companies in Argentina, Brazil and Uruguay becoming exporters. Furthermore, the use of imported input is another significant variable that increases the probability of exporting from these three countries. The estimates of the Heckman selection model proved to be inadequate (no selection bias) for all the countries in the sample except Argentina.

Keywords | Exports; Innovation; Productivity; Mercosur.

1 Introduction

The aim of this study is to gauge whether innovation efforts positively affect the likelihood of exports by manufacturing companies in Mercosur countries, namely Argentina, Brazil, Paraguay and Uruguay, seeking to identify possible similarities and differences among them. For this purpose, based on microdata from the World Bank's Enterprise Surveys database, econometric estimates are made for each of the countries individually using three models: probit; bivariate probit, to correct the problem of endogeneity; and the Heckman selection model, for the correction of sample selection bias.

Access to new markets, despite increasing possible interaction between producers and consumers, as a rule involves a careful decision-making process by companies. If, on the other hand, there are rewards to be reaped from exporting, as reaching out to more potential buyers means an advantage over the competition, on the one hand, consumer preferences vary according to local customs and cultures. Furthermore, different forms of competition and market structures oblige firms to adapt constantly, either by modifying their products or exploring new niches. Therefore, although the prize for exporting arouses interest, this task means making considerable efforts, which a firm is not always capable of sustaining.[1]

From a macroeconomic viewpoint, the aggregate increase in exports and industrial performance are directly reflected on a wide range of indicators, such as employment and inflation rates. Thus, in the late 1990s, a new research agenda was created in an attempt to understand the relationship between firms' productivity gains and exports. One piece of evidence that points to the existence of a positive correlation between exports and productivity is that wages in exporting firms are higher than in non-exporting firms (BERNANRD; JENSEN, 1995).

Several empirical studies, such as those of Wakelin (1998), Cassiman and Martínez-Ros (2010), Ganotakis and Love (2011) and Nonnenberg and Avellar (2017) have sought to understand the role of innovation and technology in a firm's propensity to export, investigating whether firms with greater innovation efforts, by improving efficiency, are in a better position to compete in the external market and survive. The results showed that innovation is indeed important to the performance of exporters, lending support to the argument for self-selection in the sense that

1 It should be mentioned that there is important literature that addresses the relationship between innovation and trade, e.g., Fagerberg, Srholec and Knell (2007), Lall (2000) and Haque *et al.* (1996). Haque *et al.* (1996) describe how innovation and technological improvements are essential for a country's economic development. Human capital, the technical skills of the workforce, managerial practices and government policies are fundamental for success in the international market.

more productive companies become exporters. In other words, gains in productivity are made before branching out to the external market.

This work contributes to the literature by individually analyzing the relationship between innovation effort and the likelihood of exporting in each Mercosur country; in other words, by recording the existence of heterogeneity within the bloc and, therefore, the specific features of each country. Previous studies using a similar approach have focused on investigating blocks of countries or only one particular country. Nonnenberg and Avellar (2017) analyzed countries aggregated into two regions, Latin America and Eastern Europe, and, therefore, without considering possible heterogeneities and the specific features of each country. In Silva and Avellar (2017), the estimates were made only for Brazil. On the other hand, by investigating the Mercosur countries individually, this study seeks, through disaggregated estimates, to pinpoint similarities between countries and the idiosyncratic characteristics of each one of them.

Evidence of intrabloc heterogeneity in terms of the content of export agendas and the relative importance of regional integration for the process of technological diffusion, in turn, has been widely documented in the literature. Nonnenberg and Mesentier (2011) found that the export agendas of Argentina, Brazil and Uruguay saw an increase in technological content following the creation of the bloc in the 1990s, when intrabloc trade is observed, while the export agenda of Paraguay remained unchanged. Since the late 1990s, Argentina, Brazil and Uruguay have increased the concentration of products linked to the automotive chain in their intra-regional export baskets, classified as medium and medium-high technological intensity goods. The authors suggested that the increase in exports of products related to the automotive industry may have stemmed from the diffusion of innovation processes resulting from policies and/or investments located in a production chain rather than the adoption of broad innovation policies. When investigating this hypothesis, Peluffo (2011) found evidence that regional integration caused technological and knowledge diffusion to Uruguay and increased productivity in manufacturing companies, a result similar to that found by Bustos (2011) for Argentinean companies.

Given the evidence of changes in the intra-Mercosur trade pattern, the intention of this study is to discuss the possible similarities and differences between Mercosur countries, treating them in a disaggregated way, that is, estimating models for the firms of each country (Argentina, Brazil, Paraguay and Uruguay).

In addition to this introduction, the work is divided as follows. In Section 2, a brief literature review is conducted, covering the main theoretical and empirical

approaches to the subject. Section 3 describes the database and exploratory analysis. The model is presented in Section 4, and the results are discussed in Section 5. The conclusions of the study are outlined in Section 6.

2 Literature review

The relationship between the stimulus to export and the impetus to innovate has been empirically investigated since the seminal work of Bernard and Jensen (1995), in which evidence was found that exporting firms would be substantially larger, pay higher wages, be more capital-intensive and show higher labor productivity compared with non-exporters.

Several studies have documented the importance of the self-selection process, by which firms, in order to access international markets, should be able not only to cover all the costs associated with selling their products in geographically distant regions, but also to adapt them to consumers with behaviors that differ from those of local consumers. Thus, companies earning higher profits than domestic companies would be able to operate beyond their borders, that is, to enter other markets.[2]

In this context, Bernard and Jensen (1999) found that both growth rates and levels of success measures are higher *ex-ante* for firms that become exporters. Corroborating this result, Wagner (2002) found that companies that began to export became more productive more quickly than those that did not begin exporting. In turn, Aw, Roberts and Winston (2007) related the decision to export with the firm's performance and found a positive and statistically significant relationship between the two variables, in the sense that superior performance leads the firm to export.

Barboni *et al*. (2012) found that, from the late 1990s to the early 2000s, the number of Uruguayan companies that exported to Mercosur partners fell from 53% to 36%, and they began instead to export to developed countries. The authors observed that accessing developed markets requires an effort to increase productivity *ex-ante* to cover the entry costs. Thus, companies that export to developed countries are more productive than non-exporters and those that export to Mercosur.

2 In the opposite causal sense, the process of learning by exporting was also documented. This is related to mechanisms that improve the firm's performance after entering the export market. The hypothesis is based on the idea that the productivity gains identified in companies are the result of greater exposure to factors such as competition, access to information, new technologies, and spillovers. Therefore, the positive externalities that permeate companies involved in foreign trade could be responsible for leveraging the levels of variables such as sales, wages and specialized work. This question was first raised by Clerides, Lach and Tybout (1998).

With the common aim of gauging the relationship between innovation and exports in companies from different countries, some empirical studies have been conducted using the information provided by Enterprise Surveys, from which the data in this study were obtained. Nguyen *et al.* (2008) reported an innovation effort with exports by small and medium-sized companies from Vietnam through three innovation indicators: introduction of a new product in the market, innovative processes and product modification. In the three innovation indicators, we found significant evidence that innovation affects exports. Balli and Sigeze (2017) linked the research and development (R&D) expenditure of Turkish companies with the decision to export. The estimations, however, signaled that innovation activity differs from the expected result: innovation efforts reduce the probability of exporting.

Microdata for Brazilian companies, also made available by Enterprise Surveys, enabled applied studies for Brazil to be conducted. For the years 2002 and 2003, Avellar and Carvalho (2013) estimated the relationship between export performance and innovation efforts in Brazil, China and India. The results indicated that, for the three countries, innovation efforts (measured through the proxies of new products, R&D expenditure and a technology or cooperation index) increased the likelihood of companies exporting. Silva and Avellar (2017) analyzed the impacts of innovation effort on the decision to export. The results revealed that characteristics such as a larger firm size and more years of experience increased the probability of trading in the international market. The innovation effort variable had a positive effect on the probability of firms becoming exporters.

Moreover, the data on Brazil were used in an aggregate study for Latin America, conducted by Nonnenberg and Avellar (2017). Contrasting the data with other aggregated data for Eastern Europe, the authors tested the relationship between exports and innovation.[3] For both Latin America and Eastern Europe, the result of the innovation indicator was positive and statistically significant. When endogeneity was controlled, the likelihood of exporting in Latin America was positively influenced by innovation, whereas in Eastern Europe no endogeneity was detected between exports and innovation. In turn, when the bivariate probit model was used, the decision to innovate had a positive and significant coefficient for both regions. Finally, when selection bias was controlled using the Heckman model to determine whether innovation influenced the intensity of exports, which

3 The first region was represented by the following countries: Argentina, Brazil, Chile, Colombia, Costa Rica, Mexico, Peru and Venezuela. Meanwhile, the second was represented by Belarus, Bulgaria, Slovakia, Hungary, Lithuania, Poland, the Czech Republic, Romania, Russian and Ukraine.

in this case is a continuous variable, the results were inconclusive. Only for Latin America was dependence found between the equations, but with very different results from the previous models, with innovation reducing or not influencing export activity.

The aforementioned articles stand out for their relevance in the literature on firms' decisions to export and, consequently, support the theoretical and empirical framework of the present study. The aim is to progress towards gaining an even more detailed understanding of the topic, supported by an analysis of companies from each Mercosur country individually to reveal the existence of possible heterogeneity within the bloc.

3 Data

3.1 Micro database: Enterprise Surveys

The data used in this work were obtained from the Enterprise Surveys of the World Bank, which were conducted at the firm level and applied periodically[4] in a set of countries, mainly in South America, Central America and Mexico, Eastern Europe, Africa and Asia. Following the empirical strategy employed by Nonnenberg and Avellar (2017), the variables of interest obtained from the questionnaire are presented in Table 1.

The choice of variables bears a resemblance to the estimations of a number of international studies, such as Wakelin (1998), Sterlacchini (1999), Sjoholm (2003) and Ganotakis and Love (2011). They can be distributed into four groups: (i) export indicators: "exports" and export intensity ("exp_int"); (ii) internal characteristics of the firm: "employees", employees squared ("employees2)", foreign capital ("foreign_cap") and "age"; (iii) qualification: quality certification ("quality_cert"), foreign technology ("foreign_tec"), "training" and imports input ("import_input"); and (iv) innovation indicators: innovation "innova" and Research and Development expenditure ("rad_expen").

4 A questionnaire is applied in face-to-face interviews at a set of companies with five or more employees through sampling. The questions are intended to provide an understanding of the company's business environment, operations, physical structure and relationship with the government, suppliers and competitors. From 2000 to 2018, the survey was applied once in 46 countries, twice in 57 countries, three times in 17 countries, four times in 20 countries, five times in six countries and seven times in two countries.

TABLE 1
Description of the variables

Variable	Ref. in Questionnaire	Type of variable	Description
		Dependent variables	
exports	d3b and d3c	Dummy	Indicates whether part of a firm's revenues stem from exports. If so, the number is equal to 1 and it is an exporter. If not, it is equal to 0 and it is not an exporter.
exp_int	d3b and d3c	Continuous	Share of export sales in total revenues.
		Independent variables	
foreign_cap	b2b	Dummy	Indicates whether more than 10% of the company's capital is owned by foreigners. If so, the number is equal to 1; if not, it is equal to 0.
age	b5	Continuous	A number that represents the age of the company.
quality_cert	b8	Dummy	Indicates whether the company has any ISO quality certification. If so, the number is equal to 1; if not, it is equal to 0.
import_ input	d13	Dummy	Indicates whether the company directly imports inputs. If so, the number is equal to 1; if not, it is equal to 0.
foreign_tec	e6	Dummy	Indicates whether the company uses foreign technology. If so, the number is equal to 1; if not, it is equal to 0.
employees	l1	Continuous	Number representing the number of company employees.
employees2	l1	Continuous	Number that represents the number of company employees squared.
training	l10	Dummy	Indicates whether the company has implemented a training program in the last fiscal year. If so, the number is equal to 1; if not, it is equal to 0.
innova	p79a (BR) and e7 (Other countries)	Dummy	Indicates whether the company has launched any new products on the market in the last three years. If so, the number is equal to 1; if not, it is equal to 0.
rad_expen	p135 (BR) and Le8a (Other countries)	Dummy	Indicates whether the company has spent money on R&D in the last three years. If so, the number is equal to 1; if not, it is equal to 0.

Source: Prepared by the authors.

Companies with foreign capital are expected to face lower entry costs, given the positive externalities generated by the experience of international partners. In addition, newer companies tend to be more innovation-intensive, giving them greater advantages when exporting. Having a quality certificate is a guarantee of

the product's quality and can serve to reduce uncertainties and make the product more competitive. Using imported inputs is an option open to companies in foreign markets. The incorporation of methods and tools used abroad makes the firm better adapted to operate in new consumer markets, thereby reducing possible entry costs. Because they have more resources and greater flexibility with regard to covering entry costs, larger firms are expected to be more likely to export. Furthermore, a non-linear relationship between firm size and exports is expected. Very large firms have a monopoly on the domestic market, directing their sales only internally. Finally, companies that implement training may see improvements in the flow of processes and, consequently, productivity gains (WAKELIN, 1998; STERLACCHINI, 1999; SJOHOLM, 2003; NONNENBERG; AVELLAR, 2017).

The samples of companies from Argentina, Paraguay and Uruguay were obtained from the survey conducted in 2006, while for Brazil the data were obtained from the 2003 survey. It is noteworthy that, for Brazil, there were no survey data for 2006, but for 2003 and 2009. In this case, to avoid possible impacts of the subprime crisis, which began in the United States in mid-2007, on the data, it was decided to consider the year 2003 for the Brazilian economy. The sample for each country was composed as follows: i) Argentina, 516 companies; ii) Brazil, 1,311 companies; iii) Paraguay, 331 companies; and iv) Uruguay, 301 companies.[5] Individuals with missing data for at least one of the variables considered were removed from the sample.

3.2 Exploratory Analysis

For the purpose of identifying elements that indicate companies' greater propensity to export, the samples were initially separated by company size, using the classification criterion available in the research questionnaire, namely: i) small companies: those with fewer than 20 employees (in Brazil, fewer than 25 employees); ii) medium-sized: from 20 to 99 employees; and iii) large: over 99 employees.

As described in Table 1, companies are considered to be exporters when a share of their annual revenue stems from sales to the foreign market. To relate the size of the company to its situation in relation to sales abroad, Table 2 groups companies from countries by size and export status. It is interesting that there is a positive relationship between company size and the proportion of exporters, a relationship confirmed for all the countries in the sample.

5 In accordance with the methodology note of Enterprise Surveys (2009), the sampling method considers the size of each economy and the sector distribution of companies, and generates a stratified random sample with different sampling weights, leading each country to have a representative sample of companies and one which can be compared in different years.

TABLE 2
Number of companies divided by size and export status

Country	Small company		Medium-sized company		Large company	
	Exports	Does not export	Exports	Does not export	Exports	Does not export
Argentina	54	127	120	83	109	23
	30%	*70%*	*59%*	*41%*	*83%*	*17%*
Brazil	20	226	148	571	212	134
	8%	*92%*	*21%*	*79%*	*61%*	*39%*
Paraguay	21	138	38	97	21	16
	13%	*87%*	*28%*	*72%*	*57%*	*43%*
Uruguay	37	109	74	54	23	4
	25%	*75%*	*58%*	*42%*	*85%*	*15%*
Total	**132**	**600**	**380**	**805**	**365**	**177**
	18%	***82%***	***32%***	***58%***	***67%***	***33%***

Source: Prepared by the authors based on the research data.

More specifically, this study seeks to understand the relationship between the variable of interest, innovation, and export activities. For each Mercosur country, Table 3 aggregates companies into four subgroups: exporters who innovate, exporters who do not innovate, non-exporters who innovate and non-exporters who do not innovate. The proxy for innovation used in this work is the launch of new products on the market.

TABLE 3
Innovative and non-innovative companies by export status

Country	Exports		Does not export	
	Innovates	Does not innovate	Innovates	Does not innovate
Argentina	244	39	161	72
	86%	*14%*	*69%*	*31%*
Brazil	228	152	457	474
	60%	*40%*	*49%*	*51%*
Paraguay	61	19	175	76
	76%	*24%*	*70%*	*30%*
Uruguay	92	42	117	50
	69%	*31%*	*70%*	*30%*
Total	**625**	**252**	**910**	**972**
	71%	***29%***	***58%***	***42%***

Source: Prepared by the authors based on the research data.

Innovative firms are the majority among the exporters in the four countries in question and, except in Brazil, also among non-exporters. In total, 71% of the exporter companies are innovative, compared with 58% of the non-exporters.

Observing the companies under study aggregated by sector, in Argentina, 82% of the companies in the sample are concentrated in the food, textile, machinery and clothing sectors (with 25%, 20%, 20% and 17%, respectively). Meanwhile, the situation in Brazil has a little more variety, with eight sectors represented. Of the total, 72% of the companies are in the clothing, furniture, footwear and machinery and equipment sectors (with 29%, 21%, 12% and 12%, respectively). In Paraguay, 89% of the firms are in the chemicals, food, other manufactured products and clothing sectors (with 30%, 23%, 20% and 16%, respectively). Finally, in Uruguay, 99% of the companies operate in the chemicals, food, clothing, and textile sectors (with 37%, 30%, 21% and 12%, respectively). Considering the entire sample, the clothing, food, chemicals and textile sectors account for 68% of the firms (with 22%, 19%, 16% and 11%, respectively).

Table 4 (exporters) and Table 5 (non-exporters) shows a collection of company statistics according to the selected variables. Some considerations can be stated about descriptive statistics and the differences between exporters and non-exporters. It is notable, for example, that exporting firms are in a minority, approximately 35% of the total. Unlike Argentina, with 54.8% exporters, most firms in Brazil, Paraguay and Uruguay do not export.

Moreover, for all the analyzed variables, exporting firms present higher values compared with non-exporters. The average age of exporting firms is 29.37 years against 19.23 of non-exporters. The country with the highest proportion of exporters, Argentina, has the highest average age for this group: 35.42 years. On the other hand, the variability of the ages of exporting firms is also greater, with 25.42 years compared to 17.77 years. Moreover, 50% of exporting firms are up to 23 years old, compared with 14 years for non-exporters.

Export intensity, in other words, the percentage of revenues that stem from sales abroad, is on average 35.90%. Using the methodological cut-off adopted to classify the exporting firms, any percentage of sales abroad makes it an exporter. This means that the magnitude of this variable cannot be distinguished, which ends up being reflected in the median value of countries such as Brazil: at most, 10% of the revenue of 50% of Brazilian exporting companies are generated from sales abroad.

TABLE 4
Exporters' statistics

Country	OBS	%[1]	age			exp_int			employees			quality_cert[2] (%)	import_ input[3] (%)	innova[4] (%)	foreign_cap[5] (%)	foreign_tec[6] (%)	training[7] (%)
			Mean	Median	S.D.	Mean	Median	S.D.	Mean	Median	S.D.						
Argentina	283	54.8	35.42	29	28.30	26.39	15	27.15	292.03	58	1204.28	41.3	67.1	86.2	18.0	20.1	39.6
Brazil	380	29.0	24.96	20	21.00	26.79	10	32.02	236.98	113.5	381.48	29.2	32.4	60.0	9.7	10.8	79.5
Paraguay	80	24.2	27.33	18	25.80	43.99	37.5	35.31	79.11	42.5	101.22	18.8	63.8	76.3	17.5	17.5	68.8
Uruguay	134	44.5	30.31	23	27.77	43.43	31	36.13	56.96	35.5	73.12	20.9	74.6	68.7	14.2	8.2	53.7
Total	**877**	**35.66**	**29.37**	**23**	**25.42**	**30.77%**	**15**	**32.32**	**212.84**	**70**	**734.30**	**30.90**	**52.91**	**71.27**	**13.80**	**14.03**	**61.69**

Source: Prepared by the authors based on the research data.
(1) Percentage of exporters in the entire sample. (2) Percentage of companies with quality certification. (3) Percentage of companies that import inputs. (4) Percentage of companies that innovate. (5) Percentage of companies with 10% or more foreign capital. (6) Percentage of companies that use foreign technology. (7) Percentage of companies that have implemented training.

TABLE 5
Non-exporters' statistics

Country	OBS	%[1]	age			exp_int			employees			quality_cert[2] (%)	import_ input[3] (%)	innova[4] (%)	foreign_cap[5] (%)	foreign_tec[6] (%)	training[7] (%)
			Mean	Median	S.D.	Mean	Median	S.D.	Mean	Median	S.D.						
Argentina	233	45.2	26.60	21	22.97	-	-	-	54.03	16	162.96	7.7	32.6	69.1	2.6	10.3	63.1
Brazil	931	71.0	15.35	12	13.83	-	-	-	59.42	32	88.89	7.6	4.5	49.1	1.3	3.8	54.8
Paraguay	251	75.8	21.11	16	16.12	-	-	-	29.62	17	38.54	5.2	39.8	69.7	8.0	11.6	42.2
Uruguay	167	55.5	27.68	23	23.84	-	-	-	22.93	13	27.75	4.2	42.5	70.1	9.0	7.8	20.4
Total	**1582**	**64.34**	**19.23**	**14**	**17.77**				**50.04**	**25**	**95.17**	**6.89**	**18.27**	**57.52**	**3.35**	**6.38**	**50.37**

Source: Prepared by the authors based on the research data.
(1) Percentage of non-exporters in the entire sample. (2) Percentage of companies with quality certification. (3) Percentage of companies that import inputs. (4) Percentage of companies that innovate. (5) Percentage of companies with 10% or more foreign capital. (6) Percentage of companies that use foreign technology. (7) Percentage of companies that have implemented training.

Another relevant factor is the difference between the average number of employees of exporters and non-exporters. In this case, exporters have an average of 212.84 employees compared with an average of 50.04 employees for non-exporters. In all the countries in the sample, exporters have a higher average number of employees than non-exporters. Furthermore, 50% of the companies that export have up to 70 employees, compared with up to 25 employees in the others.

Considering the other aspects in the two tables, the group of exporting companies has a higher percentage than the non-exporters in the following categories: those with some type of quality certification (30.90% compared with 6.89%); those that import inputs (52.91% compared with 18.27%); with innovation activity (in this case, the launch of new products on the market) (71.27% against 57.52%); with more than 10% of foreign capital (13.80% compared with 3.35%); and using foreign technology (14.03% against 6.38%).

In Argentina, firms operating in the foreign market only show a lower percentage in the implementation of new training for employees (39.6% against 63.1%). In Uruguay, the percentage is higher in the launch of new products on the market (68.7% against 70.1%). In Brazil and Paraguay, no group of non-exporting companies has higher indicators than the exporting companies.

4 Model

In discrete choice models, the rule to indicate whether an individual will be classified with a value of 1 or 0 is determined by introducing a latent variable, in other words, a non-observable variable. Consider the binary observable variable y and the continuous non-observable (latent) variable y^*, which satisfies the following model:

$$y^* = \mathbf{x}'\boldsymbol{\beta} + \varepsilon, \tag{1}$$

where $\mathbf{x}$ denotes the entire set of independent or explanatory variables, β the magnitude of the impacts of these variables, and ε the error.

Even if y^* is not observable, it can be observed that:

$$y = \begin{cases} 1, & \text{if } y^* > 0 \\ 0, & \text{if } y^* \leq 0 \end{cases}. \tag{2}$$

Taking Equations (1) and (2) as a basis, there is the following for the latent variable:

$$\begin{aligned} \text{Prob}(y = 1 \mid x) &= \text{Prob}\left(x'\boldsymbol{\beta} + \varepsilon > 0 \,\middle|\, x\right) \\ \text{Prob}(y = 1 \mid x) &= \text{Prob}\left(\varepsilon < x'\boldsymbol{\beta} \,\middle|\, x\right) \\ \text{Prob}(y = 1 \mid x) &= F\left(x'\boldsymbol{\beta}\right) \end{aligned} \quad , \tag{3}$$

where $F(\mathbf{x}'\boldsymbol{\beta})$ is the cumulative distribution function of the random variable ε. If ε is normally distributed, the probit model is obtained.

According to Ganotakis and Love (2011), Harris and Li (2009) and Lachenmaier and Woessmann (2006), in a probability model, innovation variables tend to present endogeneity, making it necessary to employ models with instrumental variables. In this work, the bivariate probit model was used, which is an extension of the probit model, formed by a system of equations in which the errors are potentially correlated. The bivariate probit may be represented by:

$$\begin{aligned} y_1^* &= x_1'\boldsymbol{\beta}_1 + \varepsilon_1 \\ y_2^* &= x_2'\boldsymbol{\beta}_2 + \varepsilon_2 \end{aligned} . \tag{4}$$

The rule of determination in this case presents two constraints:

$$\begin{aligned} y_1 &= \begin{cases} 1, & \text{if } y_1^* > 0 \\ 0, & \text{if } y_1^* \leq 0 \end{cases} \\ y_2 &= \begin{cases} 1, & \text{if } y_2^* > 0 \\ 0, & \text{if } y_2^* \leq 0 \end{cases} \end{aligned} . \tag{5}$$

The errors, ε_1 and ε_2 have a mean equal to zero, variance equal to one and correlation equal to ρ. To test the existence of a correlation between the error terms, the Wald test is used, in which the null hypothesis is $\rho = 0$ and the alternative hypothesis is $\rho \neq 0$. Thus, there will only be a problem of endogeneity if the null hypothesis is rejected, in accordance with the conventional confidence intervals.

The final stage of the estimation of this work is the estimation of the Heckman selection model, the aim of which is to investigate the relationship between innovation and export intensity (CAMERON; TRIVEDI, 2010; WOOLDRIDGE, 2010; HECKMAN, 1979). The Heckman selection model is used to correct sample

selection bias. In this case, to estimate export intensity, it is necessary to consider only the individuals classified as exporters. In the model, there are two equations, one for selection, which defines the individuals, and the other for results, which tests the relationships of interest. The model includes a selection equation:

$$y_1^* = \mathbf{x_1}'\boldsymbol{\beta_1} + \varepsilon_1, \tag{6}$$

and a result equation:

$$y_2^* = \mathbf{x_2}'\boldsymbol{\beta_2} + \varepsilon_2, \tag{7}$$

with the rule of determination given by:

$$y_1 = \begin{cases} 1, & \text{if } y_1^* > 0 \\ 0, & \text{if } y_1^* \leq 0 \end{cases}. \tag{8}$$

Once selected, the observations that will compose the sample, the result equation will be estimated only if:

$$y_2 = \begin{cases} \mathbf{x_2}'\boldsymbol{\beta_2} + \varepsilon_2, & \text{if } y_1^* > 0 \\ -, & \text{if } y_1^* \leq 0 \end{cases}. \tag{9}$$

Again, the Wald test is used to determine whether there is a correlation between the regression errors. In case of rejection of the null hypothesis, it is necessary to correct the sample selection bias.

In the probit model, the relationship between the variables is given by Equation (10):

$$\begin{aligned} \text{exports}_i = {} & \beta_0 + \beta_1 \text{foreign\_cap}_i + \beta_2 \text{age}_i + \beta_3 \text{quality\_cert}_i \\ & + \beta_4 \text{import\_input}_i + \text{foreign\_tec}_i + \beta_6 \text{employees}_i \\ & + \beta_7 \text{employees2}_i + \beta_8 \text{training}_i + \beta_9 \text{innova}_i + \varepsilon_i. \end{aligned} \tag{10}$$

Meanwhile, in the bivariate probit model, as the innovation variable, whose proxy is the launch of new products on the market, is potentially correlated with the export variable, resulting from a self-selection process or learning by exporting, an instrumental variable, R&D expenditure, is used to eliminate possible problems of endogeneity (GANOTAKIS; LOVE, 2011). The equations are:

$$\text{innova}_i = \gamma_0 + \gamma_1 \text{rad\_expen}_i + \varepsilon_i. \tag{11}$$

$$\begin{aligned} exports_i = {} & \beta_0 + \beta_1 foreign\_cap_i + \beta_2 age_i + \beta_3 quality\_cert_i \\ & + \beta_4 import\_input_i + \beta_5 foreign\_tec_i + \beta_6 employees_i \\ & + \beta_7 employees2_i + \beta_8 training_i + \beta_9 innova_i + \varepsilon_i. \end{aligned} \quad (12)$$

Finally, in the estimation of the Heckman selection model, a variable is removed from the result equation that influences the dependent variable in the selection equation. The variable that is removed is "quality_cert", as having quality certification influences the decision to export, but not export intensity (NONNENBERG; AVELLAR, 2017). Equation (13) is the selection equation and Equation (14) the result equation:

$$\begin{aligned} exports_i = {} & \beta_0 + \beta_1 foreign\_cap_i + \beta_2 age_i + \beta_3 quality\_cert_i \\ & + \beta_4 import\_input_i + \beta_5 foreign\_tec_i + \beta_6 employees_i \\ & + \beta_7 employees2_i + \beta_8 training_i + \beta_9 innova_i + \varepsilon_i, \end{aligned} \quad (13)$$

$$\begin{aligned} int\_exp_i = {} & \gamma_0 + \gamma_1 foreign\_cap_i + \gamma_2 age_i + \gamma_3 import\_input_i \\ & + \gamma_4 foreign\_tec_i + \gamma_5 employees_i + \gamma_6 employees2_i \\ & + \gamma_7 training_i + \gamma_8 innova_i + \varepsilon_i. \end{aligned} \quad (14)$$

5 Results and discussions

This section presents the results of the econometric estimates developed in this study.[6] The estimations of the probit, bivariate probit and Heckman selection models, respectively, are presented in Tables 6, 7 and 8. The dependent variable is binary, with a value of 1 if the company exports and 0 if it does not.

Regarding the bivariate probit model, in all the tables, in Equation 1, the dependent variable is binary, its value being equal to 1 if the company innovates and equal to 0 if it does not. The independent variable is R&D expenditure, which is given a value equal to 1 if the firm conducts R&D and a value of 0 if it does not. In Equation 2, the dependent variable is binary, equal to 1 if the company exports, and equal to 0 if it does not. The independent variables are the same as in the probit model.

The results of the Heckman selection model are presented in Table 8. As described above, the estimation of this model is intended to correct the sample bias

6 The estimations were made using Stata 11 software. In every case, the robust command was used to correct any type of heteroskedasticity.

problem and gauge whether innovation affects firms' export intensity. According to Nonnenberg and Avellar (2017), this is of great importance because several works have evidenced the existence of the self-selection of companies, that is, the best firms are the ones that become exporters.

Through a probabilistic model, the selection equation verifies the company's decision to export. In this case, the dependent variable is binary. The independent variables are the same as in the other models. The innovation indicator is the innovation variable (Selection equation). As for the result equation, it aims to gauge the variables that determine companies' export intensity. The dependent variable is continuous, represented by export intensity. The innovation indicator is also the innovation variable.

It should be mentioned that the model must be specified correctly and, for this purpose, a variable that affects the probability of exporting, but that does not influence the dependent variable of the result equation (export intensity), must be included in the selection equation. Following the proposal of Nonnenberg and Avellar (2017), in this work, the quality certification (quality_cert) variable was adopted for this purpose, since, according to the authors, having a quality seal affects the firm's decision to export, but is not directly related to its export intensity.

Regarding the estimation results, in the case of the probit model (Table 6), in which the dependent variable is the export status, "exports", the Wald test (Wald Statistic) rejects the null hypothesis that the coefficients are jointly equal to zero for all the countries in question. The variables "foreign_cap", "quality_cert", "import_input", "innova" and "age" were found to have significant coefficients and positively affect the export probability of Argentinean firms.

With specific regard to Brazil, most of the independent variables were seen to have statistically significant coefficients, with the variables "age", "quality_cert", "import_input", "employees," "training" and "innova" showing positive coefficients, that is, they positively affect the probability of exporting. It is noteworthy that "employees2" had a significant and negative coefficient, revealing that, for companies in Brazil, the relationship between size (measured by the number of employees) and export is non-linear (inverted-U). This result is in keeping with Nonnenberg and Avellar (2017).

For Paraguay, only the "employees" and "training" variables presented statistically significant coefficients, and they had positive signs. Finally, for Uruguay, the variables "import_input", "employees" and "training" had statistically significant coefficients, positively affecting the probability of exporting. The coefficients of "foreign_tec"

and "employees2" were significant and negatively related to the likelihood of being an exporter.

TABLE 6
Estimated probit models

Variable	Argentina	Brazil	Paraguay	Uruguay
foreign_cap	-0.2651648	0.216313	0.2318716	-0.2651648
	(0.3046312)	(0.2899893)	(0.2630689)	(0.3046312)
age	-0.0025783	0.006353	0.00277	-0.0025783
	(0.0035535)	(0.0029774)**	(0.0047129)	(0.0035535)
quality_cert	0.2792972	0.320057	0.4919853	0.2792972
	(0.3326832)	(0.1394016)**	(0.3132754)	(0.3326832)
import_input	0.519769	0.857930	0.2984272	0.519769
	(0.1787358)**	(0.1415111)***	(0.1854114)	(0.1787358)**
foreign_tec	-0.5916749	-0.027955	0.0569748	-0.5916749
	(0.3408563)*	(-0.226726)	(0.2600299)	(0.3408563)*
employees	0.0161938	0.003393	0.0092597	0.0161938
	(0.0044826)***	(0.0005883)***	(0.00328)***	(0.0044826)***
employees2	-0.0000219	-0.000001	-0.0000105	-0.0000219
	(0.0000078)***	(0.0000001)***	(0.0000078)	(0.0000078)***
training	0.6628088	0.310613	0.484689	0.6628088
	(0.1907272)***	(0.0906512)***	(0.1891025)***	(0.1907272)***
innova	-0.2736129	0.167419	-0.1127997	-0.2736129
	(0.1796908)	(0.083757)**	(0.1871888)	(0.1796908)
rad_expen	-	-	-	-
	-	-	-	-
constant	-0.1389503	-1.158253	-1.555784	-0.1389503
	(0.2758693)	(0.6043522)*	(0.2647351)***	(0.2758693)
Pseudo R^2	0.23	0.25	0.20	0.25
Wald stat.	139.62***	199.82***	56.78***	76.89***

Source: Prepared by the authors based on the research data.
1) *** Significant at 1%; ** Significant at 5%; * Significant at 10%; no asterisk represents a non-significant coefficient.
2) Robust standard errors in parentheses.

Analyzing the results of the bivariate probit model (Table 7), it was observed that the Wald independence test of endogeneity rejects the null hypothesis for the models of Argentina, Brazil and Uruguay, indicating that there is a correlation between the equations (Equations 1 and 2); in other words, they must be estimated

together. This means that there is endogeneity between the innovation variable and the export variable. However, for companies in Paraguay, the Wald test revealed that the null hypothesis of exogeneity is not rejected. Thus, for Paraguay, the standard probit model is the most suitable for analyzing the relationship between innovation and exports. Therefore, the analysis for the bivariate probit model will concentrate on the estimations for Argentina, Brazil and Uruguay.

In Equation 2, for Argentinean companies, the results are similar to those found in the probit model (Table 6). The variables "foreign_cap", "quality_cert", "import_input", "innova" and "age" have positive and statistically significant coefficients. The estimated coefficients from Equation 2 for Brazilian companies are also similar to those estimated in the standard probit model. Only a few variations, such as the statistical significance of the "age" variable, which, in this case, have a significant coefficient at 10%, and the "innova" variable is significant at 1%. The signs remain the same. For Uruguay, when introducing an instrumental variable that is not directly correlated with the dependent variable "exports", the "innova" variable began to have a coefficient with statistical significance, and with a positive sign. In other words, with the bivariate probit model being the most adequate, the "innova" variable has positive effects on the probability of Uruguayan companies becoming exporters. The other variables maintained their results in accordance with the probit.

In the Heckman selection model (Table 8), the Wald test rejects the null hypothesis only for Argentinean companies, indicating sample selection bias. In other words, for the sample of companies from Argentina, the results show that both of the firms' decisions (export and the percentage of sales from exports) are interdependent. However, for the other countries, the results indicated no selection bias, demonstrating that the Heckman is not suitable. Therefore, the analysis is restricted to Argentina.

As in the previous models, the result of the estimation of the selection equation points out that "foreign_cap", "quality_cert", "import_input", "innova" and "age" have positive and statistically significant coefficients. Meanwhile, in the results equation, in which the dependent variable, export intensity, is continuous, "foreign_cap" and "employees2" have positive and significant coefficients, whereas "age" and "employees" are negatively related to the dependent variable, with their coefficients significant at 1%.

TABLE 7
Estimated bivariate probit models

Variable	Argentina		Brazil		Paraguay		Uruguay	
	Equation 1	Equation 2	Equation 1	Equation 2	Equation 1	Equation 2	Equation 1	Equation 2
foreign_cap	-	0.6652044	-	0.258305	-	0.233342	-	-0.184043
	-	(0.24718)***	-	(0.245238)	-	(0.262439)	-	(0.168749)
age	-	0.0045343	-	0.004673	-	0.002679	-	-0.002714
	-	(0.0025571)*	-	(0.002619)*	-	(0.004681)	-	(0.002552)
quality_cert	-	0.7665244	-	0.250300	-	0.486358	-	0.263017
	-	(0.1659992)***	-	(0.117500)**	-	(0.31121)	-	(0.234369)
import_input	-	0.4679325	-	0.667701	-	0.288497	-	0.201343
	-	(0.12542)***	-	(0.13838)***	-	(0.186127)	-	(0.11986)*
foreign_tec	-	0.0845278	-	-0.087035	-	0.05452	-	-0.398354
	-	(0.1738831)	-	(0.199167)	-	(0.257755)	-	(0.156659)**
employees	-	0.0002384	-	0.002795	-	0.009123	-	0.010757
	-	(0.0003645)	-	(0.000520)***	-	(0.003265)***	-	(0.002817)***
employees2	-	0.00000000	-	-0.000001	-	-0.0000104	-	-0.0000169
	-	(0.0000002)	-	(0.00000)***	-	(0.0000076)	-	(0.000004)***
training	-	-0.0034445	-	0.221224	-	0.458749	-	0.398868
	-	(0.1207493)	-	(0.08143)***	-	(0.20544)**	-	(0.12558)***
innova	-	1.600723	-	1.252974	-	0.156421	-	1.318683
	-	(0.22137)***	-	(0.21934)***	-	(0.736243)	-	(0.105784)***
rad_expen	0.677947	-	0.492443	-	0.87729	-	0.783512	-
	(0.11786)***	-	(0.0717)***	-	(0.16852)***	-	(0.1439)***	-
constant	0.463371	-2.000426	-0.170397	-1.372632	0.276674	-1.717411	0.27877	-1.001792
	(0.08138)***	(0.25488)***	(0.04816)***	(0.50217)***	(0.08978)***	(0.46847)	(0.0803)***	(0.168104)***
Pseudo R^2	-		-		-		-	
Wald stat.	274.26***		469.41***		89.37***		-	
ρ	-0.67		-0.72		-0.17		-1	
Wald Indep. test	10.06***		8.91***		0.14		12.88*	

Source: Prepared by the authors based on the research data.
(1) *** Significant at 1%; ** Significant at 5%; * Significant at 10%; no asterisk represents a non-significant coefficient. (2) Robust standard errors in parentheses.

TABLE 8
Estimated Heckman selection models

Variable	Argentina		Brazil		Paraguay		Uruguay	
	Selection Eq.	Result Eq.	Selection Eq.	Result Eq.	Selection Eq.	Result Eq.	Selection Eq.	Result Eq.
foreign_cap	0.8130791	11.80557	0.198982	13.702990	0.2372012	33.00831	-0.2714536	13.86667
	(0.281991)***	(4.77555)**	(0.291988)	(5.31249)***	(0.266055)	(8.89856)***	(0.3038478)	(8.264484)*
age	0.004823	-0.1576673	0.006455	-0.126395	0.0021022	0.0567641	-0.0025029	-0.1544313
	(0.0028803)*	(0.0574454)***	(0.002981)**	(0.067737)*	(0.0048211)	(0.1201936)	(0.003551)	(0.0911494)*
quality_cert	0.9813711	-	0.325892	-	0.627274	-	0.2224444	-
	(0.179023)***	-	(0.138622)**	-	(0.3825714)	-	(0.5140017)	-
import_input	0.5362094	-0.4894045	0.860632	4.703935	0.2935738	-7.263856	0.5124931	-4.699158
	(0.132566)***	(3.468615)	(0.14234)***	(4.124465)	(0.1840525)	(10.5513)	(0.1798)***	(12.03245)
foreign_tec	0.171015	-0.4861239	-0.010488	-8.026171	0.0610171	-2.687904	-0.587866	-6.417757
	(0.1942268)	(4.098176)	(0.227637)	(4.053442)**	(0.2557078)	(9.108239)	(0.339742)*	(14.87679)
employees	0.0002916	-0.0084103	0.003372	-0.006703	0.009056	-0.3147572	0.0162989	-0.0790174
	(0.0004275)	(0.002973)***	(0.000592)***	(0.012175)	(0.003318)***	(0.1613427)*	(0.0045208)***	(0.2678538)
employees2	-0.0000000141	0.000000424	-0.000001	0.000004	-0.0000107	0.0005418	-0.0000223	0.0002454
	(0.00000002)	(1.63E-07)***	(0.00000)***	(0.000005)	(0.000007)	(0.00030)*	(0.000008)***	(0.0003893)
training	-0.0135153	1.689006	0.311601	-1.558254	0.4705428	-15.68038	0.6987573	1.975742
	(0.1342769)	(3.272855)	(0.09064)***	(4.228586)	(0.19025)**	(11.3425)	(0.30023)**	(13.19519)
innova	0.5741795	2.839306	0.163620	-9.384791	-0.115662	-15.11974	-0.2637761	-10.015
	(0.157720)***	(4.514207)	(0.084239)*	(3.31075)***	(0.187343)	(9.076867)*	(0.184554)	(8.67100)
rad_expen	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-
constant	-1.356007	44.96035	-1.168585	16.228150	-1.518837	95.49091	-0.147967	81.9872
	(0.283416)***	(10.4711)***	(0.599380)*	(9.463302)*	(0.27652)***	(39.8452)**	(0.282102)	(31.81246)**
Pseudo R^2	-		-		-		-	
Wald stat.	63.87***		170.30***		64.91***		95.95***	
ρ	-0.52		-0.21		-0.51		-0.27	
Wald Test	18.58***		1.41		0.79		0.06	

Source: Prepared by the authors based on the research data.
1) *** Significant at 1%; ** Significant at 5%; * Significant at 10%; no asterisk represents a non-significant coefficient. 2) Robust standard errors in parentheses.

Table 9 presents the main findings for the innovation variable for manufacturing companies in Mercosur countries. It is interesting to note that the importance of innovation efforts in export activity varies from one country to another. Except for Paraguay, innovation is an important factor that leads a company to become an exporter. This is in keeping with the result of the estimations for Latin American companies in the work of Nonnenberg and Avellar (2017), for Brazilian companies in the works of Avellar and Carvalho (2013) and Silva and Avellar (2017) and for Argentinean companies in works such as that of Marcel and Liseras (2020). In Uruguay, the main source of innovation is the acquisition of machinery and equipment, in accordance with Bianchi, Lezama and Peluffo (2015).

TABLE 9
Results found for the innovation variable

Country	Expected sign	Estimated sign	Significant	Marginal effect (p.p.)
Argentina[1]	+	+	Yes	47.74
Brazil[1]	+	+	Yes	14.52
Paraguay[2]	+	-	No	-3.18
Uruguay[1]	+	+	Yes	34.00

Source: Prepared by the authors based on the research data.
1) Result of the bivariate probit model.
2) Result of the standard probit model.

Analyzing the impact of innovation on export intensity produced controversial results that were contrary to the findings of authors such as Ganotakis and Love (2011). The estimation of export intensity, controlling for selection bias, was only significant in Argentina. However, innovation did not prove to be significant. Despite defying expectations, the same relationship between innovation effort and export intensity for Latin America was found by Nonnenberg and Avellar (2017).

In addition to the proxy for the innovation variable used in this study (launching new products on the market), works such as Avellar and Carvalho (2013) and Silva and Avellar (2017) opted for the use of foreign technology to measure innovation effort. However, econometric estimates showed that this was a significant factor for exporting only in Uruguay, with the estimated sign being negative.

The results found for Argentina, Brazil and Uruguay point to an increase in the technological content of these countries' export agendas following the creation of Mercosur, as also verified by Nonnenberg and Mesentier (2011). Therefore, the hypothesis that the consolidation of a cluster of greater technological complexity,

such as that of the automotive sector, in these countries, both in processes and products, has generated spillovers, albeit locally, to other sectors is corroborated. In addition to the innovation effort, the use of imported input in the production process increases the probability of exporting in all three of these countries.

Paraguay, in turn, showed increased diversification in labor-intensive products and natural resources (NONNENBERG; MESENTIER, 2011). According to UNESCO (2018), since the 1990s, the only products exported by Paraguay with some technological content have been pharmaceuticals. However, even regarding this industry, Arce (2010) stated that the Paraguayan State faces difficulties in providing public goods and regulation, putting the country at a disadvantage compared with the rest of Mercosur, which leads companies to produce medicines without patent permission. These factors, therefore, can help to account for the negative result for the relationship between exports and innovation in the case of Paraguay.

The reward for innovation efforts, that is, accessing new markets abroad, can be higher in sectors where innovation causes substantial changes in the quality of products and processes. According to Blyde, Iberti and Mussini (2018, p. 1654), "innovative firms do not export more than non-innovative firms when it comes to goods and markets for which quality differences are not rewarded".

In addition to the manufacturing sector, specialization in the production of low capital intensity goods is generally observed in Mercosur countries (and widely documented in the literature), especially after the increase in trade with China since the 2000s. This means that many imported technologies are from more capital-intensive countries. Consequently, foreign techniques and tools (production methods and equipment) end up not leading to advantages in production between exporters and non-exporters.

6 Conclusion

The aim of this study was to gauge whether innovation efforts positively affect the likelihood of exports from manufacturing companies in Mercosur countries: Argentina, Brazil, Paraguay and Uruguay. Furthermore, it sought to identify the local characteristics that lead manufacturing companies to export. For this purpose, Enterprise Surveys, a World Bank base of microdata, was used. Econometric estimates were performed using three models: probit; bivariate probit, to correct the endogeneity problem; and the Heckman selection model, to correct sample selection bias.

The present work contributes to the literature because, by seeking to provide a more detailed understanding of the subject, it investigates each of the Mercosur countries individually, pointing out similarities between them and the idiosyncratic characteristics of each. Furthermore, it contributes by adding evidence to the work of Nonnenberg and Mesentier (2011), in the sense that Argentina, Brazil and Uruguay have followed a path different from that of Paraguay. Works focused on analyzing regions and/or large aggregated blocks, such as that of Nonnenberg and Avellar (2017), despite making clear advances, do not allow us to point out the existence of intrabloc heterogeneity.

The results of the probit and bivariate probit models revealed that, except for Paraguay, innovation increases the probability of a company becoming an exporter. In this respect, it should be highlighted that the magnitude of the impacts of innovation efforts on the probability of a firm exporting varies according to the country analyzed. Furthermore, the Heckman selection model estimations proved to be inadequate (without selection bias) for Brazil, Paraguay and Uruguay.

Finally, when a company innovates, in addition to increasing its likelihood of becoming an exporter in countries such as Argentina, Brazil and Uruguay, as indicated by the results of this work, it can also improve its ability to compete in foreign markets to generate positive externalities and contribute to the development of the economy in which it operates. High wages, overflowing technologies and production efficiency are some of the advantages already pointed out in the literature.

In this way, it is believed that empirical studies based on microdata, such as the present work, seeking evidence of the existence of heterogeneities between the countries analyzed and, when possible, between sectors, will provide an even better understanding of the dimension of potential positive developments in the domestic economies in which innovative firms operate.

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References

ARCE, L.D. *Mercosur a prueba:* "upgrading" e innovación en las empresas exportadoras paraguayas. 93 f. (Masters dissertation) – Facultad Latinoamericana de Ciencias Sociales – Universidad San Adrés en cooperacíon com la Universidad de Barcelona, 2010.

AVELLAR, A.P.; CARVALHO, L. Esforço inovativo e desempenho exportador: evidências para Brasil, Índia e China. *Estudos Econômicos*, v. 43, n. 3, p. 499-524, 2013.

AW, B.Y.; ROBERTS, M.; WINSTON, T. Export market participation, investments in R&D and worker training, and the evolution of firm productivity. *The world economy*, v. 14, p. 83-104, 2007.

BALLI, E.; SIGEZE, Ç. The nexus between research and development and export decision: the case of Turkey. *International Journal of Business and Economic Sciences Applied Research*, v. 11, n. 1, p. 34-41, 2017.

BARBONI, J.; FERRARI, N.; MELGAREJO, H.; PELUFFO, A. Exports and Productivity: Does Destination Matter? *Revista de Economía y Estadística*, v. 0, n. 1, p. 25-58, 2012.

BERNARD, A.; JENSEN, J.B. Exporter, jobs and wages in US manufacturing: 1976-1987. *Brookings Papers on Economic Activity*: Microeconomics, v. 1995, p. 67-119, 1995.

BERNARD, A.; JENSEN, J.B. Exceptional exporter performance: cause, effect, or both? *Journal of International Economics,* v. 47, n. 1, p. 1-25, 1999.

BIANCHI, C.; LEZAMA, G.; PELUFFO, A. *Determinantes de la innovación en la industria uruguaya 1998-2009*. Instituto de Economia – IECON, 2015. (Documentos de Trabajo, n. 07-15).

BLYDE, J.; IBERTI, G.; MUSSINI, M. When does Innovation Matter for Exporting? *Empirical Economics*, v. 54, n. 4, p. 1653-1671, 2018.

BUSTOS, P. Trade Liberalization, Exports, and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinian Firms. *American Economic Review*, v. 101, n. 1, p. 304-340, 2011.

CAMERON, A.C; TRIVEDI, P.K. *Microeconometrics using Stata*. USA: Stata Press Publication, 2010.

CASSIMAN, B.; MARTÍNEZ-ROS, E. Product innovation and exports: evidence from Spanish manufacturing. *Review of World Economics/Weltwirtschaftliches Archiv*, v. 146, p. 657-689, 2010.

CLERIDES, S.; LACH, S.; TYBOUT, J. Is learning-by-exporting important? Micro-dynamic evidence from Colombia, Mexico and Morocco. *The Quarterly Journal of Economics*, v. 113, n. 3, p. 903-947, 1998.

ENTERPRISE SURVEYS. *Sampling methodology*. 2009. Available in: https://www.enterprisesurveys.org/content/dam/enterprisesurveys/documents/methodology/Sampling_Note.pdf. Access in: 25 Sept. 2020.

FAGERBERG, J.; SRHOLEC, M.; KNELL, M. The competitiveness of nations: why some countries prosper while others fall behind. *World Development*, v. 35, n. 10, p. 1595-1620, 2007.

GANOTAKIS, P.; LOVE, J. R&D, product innovation and exporting: evidence from UK new technology firms. *Oxford Economic Papers*, v. 63, n. 2, p. 279-306, 2011.

HAQUE, I.U.; BELL, M.; DAHLMAN, C.; LALL, S.; PAVITT, K. *Trade, Technology, and International Competitiveness*. The World Bank, 1996. Available in: https://elibrary.worldbank.org/doi/abs/10.1596/0-8213-3418-2. Access in: 27 Mar. 2021.

HARRIS, R.; LI, Q.C. Exporting, R&D and absorptive capacity in UK establishments. *Oxford Economic Papers*, v. 61, n. 1, p. 74-103, 2009.

HECKMAN, J.J. Sample selection bias as a specification error. *Econometrica*, v. 47, n. 1, p. 153-161, 1979.

LACHENMAIER, S.; WOESSMANN, L. Does Innovation cause exports? Evidence from exogenous innovation impulses and obstacles using German micro data. *Oxford Economic Papers*, v. 58, n. 2, p. 317-350, 2006.

LALL, S. The technological structure and performance of developing country manufactured exports, 1985-98. *Oxford Development Studies*, v. 28, n. 3, p. 337-369, 2000.

MARCEL, L.; LISERAS, N. Mejorar el desenpeño innovando y exportando: evidencia en empresas industriales argentinas. *Tec Empresarial*, v. 14, n. 3, p. 50-71, 2020.

NGUYEN, A.N.; PHAM, N.Q.; NGUYEN, C.D.; NGUYEN, N.D. Innovation and export of Vietnam's SME sector. *The European Journal of Development Research*, v. 20, n. 2, p. 262-280, 2008.

NONNENBERG, M.J.B.; AVELLAR, A.P.M. Exportações e processos inovativos: um estudo para América Latina e Europa do Leste. *Nova Economia*, v. 27, n. 3, p. 577-607, 2017.

NONNENBERG, M.J.B.; MESENTIER, A. *A criação do Mercosul para aumentar a intensidade tecnológica das exportações da região?* Brasília: IPEA, 2011 (Texto para Discussão, n. 1644).

PELUFFO, A. *Integración regional y difusión de tecnología*: el caso uruguayo. Instituto de Economia – IECON, 2011. (Documentos de Trabajo, n. 10-11).

SILVA, J.C.; AVELLAR, A.P. Esforço inovativo e exportação: um estudo para o setor industrial brasileiro. *In*: ENCONTRO NACIONAL DE ECONOMIA INDUSTRIAL E INOVAÇÃO, 2., 2017, Porto de Galinhas. *Proceedings*. Available in: https://www.proceedings.blucher.com.br/article-details/esforo-inovativo-e-exportao-um-estudo-para-o-setor-industrial-brasileiro-26602. Access in: 18 July 2019.

SJOHOLM, F. Which Indonesian firms export? The importance of foreign networks. *Paper in Regional Sciences*, n. 82, n. 3, p. 333-350, 2003.

STERLACCHINI, A. Do innovative activities matter to small firms in non-R&D intensive industries? An application to export performance. *Research Policy*, v. 28, n. 8, p. 819-832, 1999.

UNESCO. *Relevamiento de la Investigación y la Innovación en la República del Paraguay*. Paris, Unesco, 2018. (Colección GO SPIN, v. 8).

WAGNER, J. The causal effects of exports on firm size and labor productivity: first evidence from a matching approach. *Economics Letters*, v. 77, n. 2, p. 287-292, 2002.

WAKELIN, K. The role of innovation in bilateral OECD performance. *Applied Economics*, v. 30, n. 10, p. 1335-1346, 1998.

WOOLDRIDGE, J. M. Econometric analysis of cross section and panel data. 2nd ed. The MIT Press, 2010.

WORLD BANK. *Enterprise Surveys*. Available in: https://www.enterprisesurveys.org. Access in: 20 Nov. 2018.

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