# A firm-level analysis of the impact of internationalization on innovation: a study of five Latin American countries

*Bachelor thesis*

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**Abstract**

This study examines the effect of internationalization on the innovation performance of companies. Using panel data on firms in Mexico, Colombia, Argentina, Peru and Chile this paper determines the causal impact of internationalization on firm innovation on both the country and the aggregate level through propensity score matching. This makes possible comparisons between different countries and also between a country and the aggregate level results. The paper finds significant "learning-by-doing" effects of internationalization on the probability of acquiring patents abroad and international quality certificates both on the country and on the aggregate level. Those results remain significant after implementing a two-time period propensity score matching method with the aim of examining the long-term effects of internationalization on innovation performance of firms. For the other five innovation measures examined the evidence has been more inconclusive, leading to significant results for some countries and overall, almost all of which are positive, but also leading to some statistically insignificant results.

***Keywords:*** firms, internationalization, exporting, innovation, Latin America

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THE EFFECTS OF INTERNATIONALIZATION ON INNOVATION OF FIRMS IN LATIN AMERICA

## 1. Introduction

Innovation has been a subject of broad and intense controversy during the past few decades. Already in 2013 the article "The great innovation debate" (The Economist, 2013) raised the concern that innovation is slowing down and the progress made is mostly in terms of large improvements rather than breakthrough ideas. In the public imagination though this century may appear as the most innovative age so far since people living in this century are witnesses of these changes and perceive them as more significant than they actually are. This decline in innovation could lead to detrimental effects on the economic growth potential of countries and private businesses in the world. Hence numerous studies have attempted to shed light on the factors that determine the innovation level in a country. But the secret to continuous innovation though has not been revealed yet. Is it an innate or an acquired ability of companies and countries?

Recent research has attempted to identify whether internationalization could be one of the driving forces of innovation since it is becoming a phenomenon of increasing significance especially nowadays when competitiveness in most domestic markets is enormous. Companies become increasingly larger and often specialized in the production of just a limited number of products that they need to export internationally because of the overproduction of a certain good in which they have a comparative advantage.

Latin America is a highly important continent to research since the innovation gap between developed and developing countries is one of the reasons why the latter still cannot catch up with the former. Innovation in Latin American countries has a long way to go before it reaches the levels of developed countries. The enormous differences that have emerged at the end of the 20$^{th}$ century make catching up an especially difficult and long process. In 1997, "Latin American firms were 50 times less likely to patent a world-class innovation than their western European counterparts" (Porter & Stern, 2001). But it is widely accepted that precisely innovation could improve the growth potential and competitiveness of not only developing countries, but of every nation (Pietrobelli & Rabellotti, 2011). Consider the report of The World Economic Forum where it was acknowledged that the continent cannot reach its full competitiveness potential because of lack of skilled labor and innovation within the firms. One of the problems of Latin America is the lack of continuous innovation which leads to just incremental innovation. (World Economic Forum, 2015) In order to make a significant improvement over their living standards and catch up with the advanced countries, Latin American countries need higher than average

growth which means also higher than average increase in competitiveness of the companies that could come from a significant increase in innovation.

While numerous studies have been tackling the matter of how has the entrance of the developing Latin American countries affected the macroeconomic conditions in the country, there is a lack of literature addressing the effects for this region on the micro level. This topic, however, is crucial since innovation is considered by many business owners the needed remedy that will boost a company's profitability by keeping it ahead of competition. Moreover, very importantly, firm-level innovation contributes to nation-wide innovation levels. Because of this high significance of innovation for the countries and the continent, this paper uses a propensity score matching in order to examine the immediate effects, but it adds to this research by also exploring how becoming an exporter affect the probability of a firm to engage in innovation after a time period of four years.

The paper contributes to the consistently growing literature on internationalization and its effect on firms' performance, while at the same time it adds to this literature by looking at how exposure to international markets affects innovation. While there seems to be an abundance of literature looking at the effects on productivity, the effect on innovation has not gotten enough attention. Moreover, despite the almost unanimous conclusions made for productivity, interestingly enough, the results obtained for innovation have been inconclusive or have concluded that it has an impact on only some of the innovation characteristics. This could be concluded from studies such as Castellani & Zanfei (2010) who perform a research on the impact of internationalization on both productivity and innovation. They reach the conclusion that while both the companies carrying out production activities and the ones with non-production activities abroad experience increases in productivity with the former experiencing higher gains than the latter, this is not so straightforwardly true for innovation. They find that only the companies that have production activities abroad could experience increases in innovation. That means that internationalization by itself does not guarantee an increase in innovation on the firm level. Hence, this research has important policy implications for countries in general, but in particular for countries in Latin America.

The aim of this paper is to examine the causal effect of internationalization on the innovation performance of companies in the five Latin American countries. To this end, the paper is going to first control for the observed covariates in order to achieve similar to randomized distribution of observations and after that recover the effect of exporting on the innovation levels of the firms that achieved internationalization. To achieve this goal, the rest of the paper is organized as follows. Section

II is going to give a comprehensive overview of some of the literature on this topic and the conclusions it has come to, Section III is going to describe the data used and the method applied. In addition, it is also going to discuss the robustness of results and perform an additional robustness check by implementing a model with two-time period propensity score matching to account for the long-term effects of internationalization on innovation performance. Section IV is going to provide a discussion of the results and make a comprehensive conclusion.

## 2. Theoretical background

Most theoretical research on this topic has reached the conclusion that internationalization leads to better performance of the firms that enter international markets. Despite the lack of enough research on the firm-level impact of internationalization in Latin American countries, those that do research this topic, however, reach mixed conclusions. Prior research by Alvarez and Robertson (2004) on the relationship between innovation and trade openness in Mexico and Chile has reached the conclusion that "exporting has the strongest link to investment in innovation". Moreover, this research finds that plants that export to developed countries are more likely to upgrade their technological process, while plants that export to developing countries are more likely to innovate in R&D and product design. (Alvarez & Robertson, 2004)On the contrary, more recent research by Brown & Gusman (2014) focusing on the manufacturing sector in Mexico finds no statistically significant impact of exports on innovation efforts of the company.

There are, however, two hypotheses as to why the firms that start exporting are more productive and innovative. The first hypothesis concentrates on the preexisting characteristics of the firms. It attributes the higher productivity of exporting firms to the self-selection of exporting companies. In contrast, the second hypothesis although it recognizes the higher pre-existing innovation and effectiveness of company, it highlights the acquired knowledge after entering international markets and attributes a good part of the higher innovation to the fact that companies "learn" by exporting.

### 1.1. The self-selection theory

Probably one of the first papers to start the literature on self-selection is Melitz (2003). In this paper, he assumes that only the most productive firms enter the export market (self-selection) and concludes that although there are overall welfare gains from trade, that does not necessarily mean that each individual firm gains. On the contrary, some firms (the most productive ones) gain very much whereas the least productive firms lose considerably from exposure to trade and some have to exit the industry. That

conclusion excludes the "learning by exporting" hypothesis. Girma, Greenway and Kneller (2004) contribute to this field by using a large panel dataset on U.K. firms and a matching method. They determine the probability of a company becoming an exporter according to the TFP, size, ownership and wages at time *t-1.* By implementing matching technique and the difference-in-differences method they reach the conclusion that firms that become exporters experience a positive effect on their productivity which is due to self-selection (Girma, Greenway &Kneller, 2004). Likewise, Clerides, Lach and Tybout (1998) perform this research for Colombia, Mexico and Morocco and find that there is a positive correlation between becoming an exporter and efficiency that they attribute almost completely to self-selection. They also find evidence that exporters generate positive externalities for the non-exporters in the country. Moreover, their research leads to the conclusion that in Colombia there are also cost reductions for the companies operating in those regions of the country where increasingly more firms engage in exporting. (Clerides, Lach, & Tybout, 1998) In a study of German firms Arnold and Hussinger (2005) reach the conclusion self-selection is the most important reason why exporting firms are more productive than the other ones and conclude that there is almost no post-ante effect of entering international markets and most of the effect is just because of self-selection. Delgrado et al. (2002) find evidence for self-selection and very weak evidence to support the hypothesis of learning and only for younger firms among Spanish firms. In a paper expanding upon the latter, Farinas and Martin-Marcos (2003) also reach the conclusion that self-selection is the reason why exporting firms are better performers based once again on data from Spanish firms. Bernard and Wagner (1997) build upon this hypothesis drawing the conclusion that already a few years before the firms start exporting, they already are better performers than the rest in terms of employment, shipments and productivity. They find that performance of companies after exposure to international markets does not alter in most of the cases or in the worst cases it even leads to worse performance. They attribute this to the fact that some companies have to exit the international market and that leads to bad consequences for those firms.

### 1.2. The "learning-by-doing" hypothesis

In contrast, another study that uses the matching method in order to find whether internationalization has an impact on productivity is the study of De Loecker (2007a) which is based on data for the whole manufacturing sector in Slovenia. Although he finds that there are differences in the characteristics between exporters and non-exporters at the first place, he still finds support for the "learning by exporting hypothesis" and concludes that firms become on average 8.8% more productive after

becoming exporters. (De Loecker, 2007a) In another paper De Loecker (2007b) suggests a method to include the variable price which is often omitted when calculating productivity. This time he performs a research on the textile industry in Belgium and finds still positive, but much lower estimates for the productivity gains from internationalization. Similar to Alvarez and Robertson (2004), he also finds that the firms that export to high-income countries gain the most (De Loecker, 2007b). Yasar and Rejesus (2005) perform the same type of research for manufacturing firms in Turkey and also find a positive relationship that they attribute to "learning-by-exporting" (Yasar & Rejesus, 2005). The reason for that Cheung (2010) finds in the positive spillover effects that exports of domestic firms generate. Another confirmation of the hypothesis that firms learn by exporting is presented by Salomon and Shaver (2005). They draw this conclusion by employing the method of excluding all the firms that have some foreign ownership since they consider them as being able to obtain much more easily information about the foreign markets (Salomon & Shaver, 2005), which puts them in a more advantageous position. Important for this paper is the conclusion that Fernandez and Isgut (2005) reach since they focus their research on Colombian firms during the ten years between 1881 and 1991. They find quite significant results in favor of the "learning-by-exporting" hypothesis, being more important for young plants and plants that export to high-income countries. Another paper not looking at developed economies as well but at the ones in transition is the one of Boermans and Roelfsema (2015) where even after controlling for the difference in institutional legacy systems, they still find positive effects of internationalization on innovation. They find that not only exporting as an internationalization variable but also outsourcing and FDI as other types of internationalization have a significant impact on innovation, with the difference being the type of internationalization they contribute to. This conclusion is in line with the findings of Navaretti and Castellani (2004) that firms that make foreign investments are better performers. Their study concludes that firms making investments abroad are experiencing a higher rate of growth of TFP and output, which becomes even higher after the investment has occurred, i.e. post-internationalization "learning effects" have developed.

### 1.3. Hypothesis development

Based on the abovementioned conclusions of the theoretical literature, the expectation is that there is a positive impact of internationalization not only on productivity, but also on innovation within a company. Most studies find evidence that self-selection into export markets exists, while the literature is more inconclusive on whether learning after entering the international market exists. This makes

applying a method that would correct for self-selection into treatment crucial for inferring causality and being able to check for a learning effect.

## 2. Data and Methodology

The analysis is based on firm-level data on Mexico, Colombia, Argentina, Peru, Chile from the Enterprise Surveys, The World Bank Group[1]. It constitutes a panel of a total of 10,701 firms based on the same surveys conducted in companies in the five Latin American countries during 2006 and 2010. In particular, for all countries taken together, 3,434 firms have been surveyed only during 2006, 3,751 firms have been surveyed only during 2010 and 1,758 firms have been surveyed during both 2006 and 2010 contributing to the dataset with two observations[2]. This database of the World Bank Enterprise Surveys was used by Murat Seker (2011) as well in order to perform a research on the same topic. In his comprehensive survey, however, he includes data on 43 countries and distinguishes between four types of companies according to trade status – exporters, importers, exporters and importers, and firms that do not engage in any kind of trade, whether exporting or importing.

Considering all the five countries in 2006 out of the 5,192 responses of firms given for all the five countries [3]taken together, only 26.95% reported having any export activity that represented on average 31.84 % of all the sales of all the exporting companies. In 2010, a significantly larger part of the companies surveyed reported that exports were contributing to their overall sales, 36.01%, but the mean is lower – 28.29 %.[4] Over time, more companies start exporting, but this activity is a smaller part of their sales on average. This holds true for the companies in each one of the five Latin American countries. Possible explanations for that could be the fact that increasingly more small companies enter the international markets since it has become easier for them or that the more companies enter in the market the less opportunities there are for them to exploit. And, finally, this result could also be attributed to the idea that companies could start making even more sales on the national level so the exports as a % of all the sales of the company decrease without the nominal amount of them decreasing. Looking at the industry distribution, the industry which has the highest percentage of

[1] More information on the surveys and data could be found on the website of Enterprise Surveys, the World Bank Group: http://www.enterprisesurveys.org/.
[2] For information on the number of firms interviewed each years within each country refer to Appendix A: Table 1
[3] For more information on the share of exports as a percentage of overall sales broken down by year and country refer to Appendix A: Table 3
[4] More information on the number of interviewed firms according to exporting status broken down country and year could be found in Appendix A: Table 2

exporting firms (about 74%) is Basic metals. The same industry has a high percentage of firms that use international licensed technology (23.4%), which could be seen as another type of internationalization, compared to the other industries, being surpassed in this indicator only by the industry of Non-metallic minerals where about 28% of the companies are using international licensed technology. Although these results seem important what should be pointed is that the number of firms in the sample entering in these two categories, especially in the Basic metals category, is quite small relative to a good part of the other industries.

Internationalization is associated with sunk costs (Girma, Greenaway & Kneller, 2004) that act as a natural barrier and prevent many smaller and less productive firms from entering the international markets. This logically leads to support of the hypothesis of self-selection. Since also most of the theoretical literature finds evidence of this theory, I would consider the variables that determine the possibility of a firm entering the international market as well as the variables determining internationalization and innovation level of the firm.

First, looking at the variables defining the level of innovation in the firm, it could be seen that the firms that export any amount of their production are more innovative than their counterparts and have a higher probability of engaging in any kind of innovation considering that the means represented are for dummy innovation variables that take values between 0 and 1. The table is constructed with aggregate data for all five countries together.

**Table I.**

**Means of innovation variables for exporting and non-exporting firms**

| Innovation variables | **R&D investment** | **Patents abroad** | **Patents in domestic country** | **International Quality Certifications** | **Prod innovation w/n establishment(last 3y)** | **Prod innovation w/n industry (last 3y)** | **Cooperat on innov with other enterprises/institute(last 3y)** |
|---|---|---|---|---|---|---|---|
| Exporting Firms | .65 | .202 | .48 | .48 | .61 | .56 | .28 |
| Non-exporting Firms | .38 | .04 | .37 | .15 | .48 | .56 | .15 |

Data from Enterprise Surveys, the World Bank Group [1]

This evidence does not point, however, to the cause of those higher levels of innovation in the exporting firms due to the high possibility of self-selection. In order to account for these heterogeneous characteristics of the firms, I am going to use the propensity score matching method. The propensity score matching (Rosenbaum & Rubin, 1983) would be particularly useful in that case since the data is not a result of randomized control trial, but it is panel data in which the probability of selection bias is significant. In the case of selection bias the regression analysis would overestimate the effect of internationalization on the innovation of a company and would retrieve an effect that represents the true causal effect of internationalization on innovation plus a significant selection bias.

Most studies use the propensity score matching method in order to distribute observations according to their probability of becoming exporters, while a relatively small part of the papers on this topic use the instrumental variables method or some combination of both (Nguyen et al, 2008) in order to solve the problem of endogeneity. I implement the propensity score matching method as suggested by Guo & Fraser (2010) as one of the methods to correct for selection bias. Since self-selection is realistic to be assumed as random (Guo & Fraser, 2010, p.284), the method of propensity score matching would be appropriate in that case because the firms are not randomly assigned to the treatment, being in this case the exposure to international trade.

I use the variable exporting as the internationalization independent variable. Although exporting status is the internationalization variable I would focus on in the paper, the probability of acquiring an international licensed technology is another not as important, but still significant variable that I would examine in Appendix E, while still not including it in the main research. Seven binary dummy innovation variables are used as dependent variables in the main model namely R&D investment, patents abroad, patents in domestic country, international quality certificates, cooperation on innovation, product innovation in establishment and product innovation in industry. Size, TFP and foreign ownership are the covariates that I am going to control for in the research. Some of these variables chosen coincide with the ones used in the study of Seker (2011) that uses the same database to study the impact of both exporting and importing on innovation, while still using a broader range of variables in order to do that. More information on them could be found in Appendix A: Table 4.

## 3. Empirical Model

The overwhelming conclusion reached on self-selection into treatment means that regression analysis would lead to a biased estimate of causal relationship because of the existence of endogeneity. Self-selection would lead to biased upward results for the treatment effects. In order to avoid that the model implemented is a propensity score matching (Rosenbaum & Rubin, 1983). In order to execute it, I am first going to redistribute the observations according to their probability of becoming exporters based on a few significant observed covariates. Second, using this new matched treated and untreated observations, I am going to retrieve the average treatment effect on the treated.

As usual when using a sample and not the whole population of firms here I make the assumption that the firms that have been interviewed are representative of the whole population of firms. This assumption seems realistic because of the large number of firms surveyed and no evidence of sample selection bias.

### 3.1. Estimation of TFP

For the estimation of the balancing score it is very important to consider total factor productivity. Since the data does not provide this information the variable is calculated, in line with many other studies, as a residual to a Cobb-Douglas production function:

$$Y = AK^{\alpha}L^{\beta} \quad (1)$$

with two factors of production – capital and labor. The Cobb-Douglas production function is calculated by taking the natural logarithms of sales, capital and labor. Sales have been adjusted with the historical exchange rate for the particular country and year with data taken from World Development Indicators, the World Bank[5]. The variable capital is calculated as the sum of the replacement value of machinery vehicles and equipment and land and buildings in the previous fiscal year (Seker, 2011). Labor is calculated as the sum of the number of permanent full-time employees and the number of temporary full-time employees. The results obtained from the logarithmic OLS regression are significant, with an R-squared equal to 0.7357, p-values all equal to 0.000 and significant at the 1% significance level.[6]

[5] The exchange rates used could be found in Appendix B: Table 1.
[6] The results from the OLS regression could be found in Appendix B: Table 2.

For the five Latin American countries, the results obtained for total factor productivity show that the firms exporting are exhibiting a mean of 0.173 total factor productivity whereas the average productivity of non-exporters is -0.101.[7] The results show that in all countries separately the exporters have a higher and positive TFP unlike the non-exporters that always have a slightly negative TFP. The exporters also experience a slightly higher standard deviation in the TFP of exporting firms of 1.115 compared to 1.023 for non-exporting firms.

### 3.2. Probit model for exporting

For the propensity score model the variable exports is transformed into a binary dummy variable {0,1} that takes the value of 0 when the company does not export at all and takes the value of 1 if the company exports any amount of it production that contributes to its sales. That means that it would be appropriate in this case to use a probit model.

The model predicting the probability of being treated, i.e. becoming an exporter is quantified according to a model that includes as explanatory (control) variables size, foreign ownership (only if 25% of the firm or more is owned by private foreign individuals) and total factor productivity. Those are the covariates strictly controlled for in order to achieve a better, more similar to randomized assignment to internationalization. Year dummies are consistently applied in the models for every country although they usually have a low significance (with the exception of Mexico where year of survey is significant at the 1% level; Peru where the year of survey is significant at the 5% level and on the aggregate level where it is significant on the 5% level) and their coefficients are not presented in the table but they affect the coefficients of the other variables. Industry dummy variables not included because of the limitations of the data used, in particular, a large amount of missing data reducing hugely the observations in a probit model if included and because using only a few industry dummies is inappropriate either since statistical significance of industries is not consistent among countries. The variables included in the model strictly represent only firm characteristics that reflect the probability of the firm of becoming an exporter rather than the overall business environment. Hence, country dummies are included for the aggregate data, excluding Chile which is taken as the reference country (and has an insignificant coefficient), but all four other country dummies included result to be significant on the 1% level. This result is in line with research by Porter and Stern (2001) that finds that the business environment in a country has a very important influence on the innovation output in this country. That

[7] The mean total factor productivity of firms according to their exporting status broken down by country could be found in Appendix B: Table 3

means that the innovation climate is influencing the amount of investment and effort put into innovation activities irrespectively of the influence of internationalization or other activities on innovation. By using the propensity score as defined by Rosenbaum and Rubin (1983) and in line with the notation of Becker and Ichino (2002) the model is defined as follows and the results could be found in table III:

$$p(X) = Pr(Exp = 1|X(Size, TFP, For\ own)) \quad (2)$$

**Table III.**

**Probability of becoming exporters (probit model)**

| Control variables | Mexico | Colombia | Argentina | Peru | Chile | Total |
|---|---|---|---|---|---|---|
| **Size** | .416*** | .494*** | .377*** | .400*** | .572*** | **.444*** ** |
| **Foreign ownership** | .817*** | .767*** | .721*** | .545*** | .717*** | **.700*** ** |
| **Total Factor Productivity** | .089** | .017 | .200*** | .018 | .180*** | **.109*** ** |
| *Pseudo $R^2$* | *0.2557* | *0.1984* | *0.1552* | *0.1575* | *0.2379* | *0.2258* |
| *Number of obs* | *1949* | *1154* | *1023* | *862* | *1122* | *6110* |

*Notes*: The propensity score matching is implemented with replacement as set by default in the psmatch2 command.
The balancing property of the propensity score is satisfied for all countries except Colombia and the aggregate data.
* The coefficient is statistically significant at the 10% level
** The coefficient is statistically significant at the 5% level
*** The coefficient is statistically significant at the 1% level

### 3.3. Estimation of the causal effect of internationalization on innovation

In this case the average treatment effect on the treated is implemented since the focus of this research is the causal effect of exposure to internationalization on the firms that were treated, i.e. that were internationalized. The average treatment on the treated would represent the difference between the innovation outcome for the firms that internationalized minus the innovation outcome for those same firms that did ultimately internationalize had they not internationalized. The second term is not observed, but it is rather predicted. Following the notation of Becker and Ichino (2002), the model looks as follows:

$$ATT = E(Y(1)|Exp = 1, p(X)) - E(Y(0)|Exp = 1, p(X)) \quad (3)$$

In this model *Y* denotes the innovation outcome. The reason to use the average treatment on the treated is that I consider the barriers to entering international markets (Girma, Greenaway & Kneller,

2004) significant enough to not permit the small or less productive firms to start internationalizing. That means that self-selection occurs naturally and is significant enough to exclude the firms that did not internationalize from the final estimation, which is presented in Table IV.

**Table IV.**

**Results for the causal effect of exporting on innovation (ATT)**

| Innovation variable | Mexico | Colombia | Argentina | Peru | Chile | Total |
|---|---|---|---|---|---|---|
| **R&D investment** | .089 | .133** | .142* | .182** | .058 | **.137*** |
| **Patents abroad** | .119*** | .131* | .125** | .088** | .147** | **.122*** |
| **Patents in dom country** | .003 | .016 | .042 | .081 | -.086 | **.075*** |
| **International Qual Cert** | .131*** | .119** | .236*** | .078* | .132*** | **.136*** |
| **Cooperation on Innov** | -.009 | .029 | .188*** | -.004 | .129** | **.077**** |
| **Prod inn in estab** | .071 | .127 | .071 | .230*** | .25*** | **.123*** |
| **Prod innov in industry** | -.16* | .172 | -.013 | .184* | .135 | **-.002** |

*Notes:* Implemented through psmatch2 command in Stata (Leuven & Sianesi, 2015) for retrieving the average treatment effect based on nearest neighbor matching. The ATT is determined by executing the psmatch2 command for every single outcome and not for all outcome variables at the same time. The significance level is determined through bootstrapping by default with 50 replications.

* The coefficient is statistically significant at the 10% level

**The coefficient is statistically significant at the 5% level

*** The coefficient is statistically significant at the 1% level

### 3.4. Robustness of results and limitations

The initial bias for the unmatched sample has been significantly reduced. The remaining bias after matching is relatively small and there are no variables exhibiting a negative reduction in bias except for TFP in Colombia. The tables with all the values for bias remaining after matching and bias reduction could be found in the Appendix C: Table 1 & Table 2. The balancing score, however, is based only on the three observed covariates that affect both the decision to internationalize and the one to innovate (Rosenbaum & Rubin, 1983), but there exists the possibility of more covariates being present that still create bias although not as important as the one that the three covariates presented here create.

As an additional robustness check, the same model is implemented but taking into account the two time periods (2006 and 2010) in the data in order to examine the long-term effects of internationalization on innovation. Unlike many other papers that use the difference-in-difference method for examining this question, in this study the propensity score matching is applied. To this aim, I first estimate a probit model only for the observations in 2006, after that based on it I predict the propensity score. Finally, I use the propensity score obtained for a propensity score matching of the innovation outcome observations obtained only during 2010. In that way the ATT are obtained again, but they reflect the causal effect of becoming an exporter in 2006 on the innovation performance of companies in 2010. Once again following Becker and Ichino's notation the model is as follows:

$$ATT = E(Y_{t+4}(1)|Exp_t = 1, p(X)) - E(Y_{t+4}(0)|Exp_t = 1, p(X)) \quad (4)$$

For the model representing the probability of becoming exporters the same variables are used as before – size, foreign ownership and TFP - but in this probit model, unlike the previous one, TFP is considerably less significant explanatory variable for Mexico, Colombia and Peru, while for Colombia foreign ownership results being insignificant as well. This could be attributed to the fact that the percentage bias in TFP before matching this model was not high at the first place (-6.5% for Mexico, -5.1% for Colombia, 16.1% for Peru, compared to the much higher 29.9% for Argentina and 27.3% for Chile). Nonetheless, the adjusted $R^2$ results are in the range of 0.1100 to 0.2373 for the country models, while for the aggregate data all three explanatory variables are significant on the 1% level and pseudo $R^2$ is equal to 0.2401, which is similar to the result which many other studies on this topic achieve. Similarly, the reduction in bias for the aggregate data on the five countries is quite significant although in a few instances for the country specific probit models a negative reduction in bias in the explanatory variables could be seen. Despite that the reduction in bias achieved for the aggregate data is 94.4% for size, 96.4% for foreign ownership and 47.3% for total factor productivity. All the results from the probit model and their robustness could be found in Appendix D and below are presented only the results for the average treatment effects on the treated and discussed in the next section.

**Table V.**

**Results for the long-run causal effect of exporting on innovation (ATT)**

| Innovation variable | Mexico | Colombia | Argentina | Peru | Chile | Total |
|---|---|---|---|---|---|---|
| **R&D investment** | .126** | .180*** | .170** | .157** | .040 | **.092*** ** |
| **Patents abroad** | .078* | .139*** | .132*** | .092*** | .171*** | **.131*** ** |
| **Patents in dom country** | -.012 | .032 | .069 | .044 | -.136*** | **.054*** |
| **International Qual Cert** | .229*** | .210** | .274*** | .081 | .171*** | **.198*** ** |
| **Cooperation on Innov** | -.023 | .049 | .160*** | .011 | .161** | **.040** |
| **Prod inn in estab** | .056 | .168** | .058 | .236*** | .291*** | **.137*** ** |
| **Prod innov in industry** | -.120* | -.025 | .050 | .205** | .128 | **.004** |

## 4. Discussion and conclusion

The results show that internationalization contributes to innovation, being more significant for some forms of it than for others. Internationalization in these five Latin American countries has the most important impact on the probability of acquiring a patent abroad or an international quality certificate. In particular, the impact of exporting on the probability of acquiring international patents is statistically significant and positive for each one of the five countries and for the aggregate data. This effect is reinforced in the long run for all of the five countries, with the only exception of Mexico. The same trends are visible concerning the probability of acquiring an international quality certificate that increases significantly for firms in each country thanks to innovation and becomes even more probable in the long run for each country (with the exception of Peru where in this model loses its significance). This significant results could be predicted also from looking at the correlations table in Appendix A, where it could be seen that out of the seven innovations variables, international quality certificates has the highest correlation with exporting of 0.3924, patents abroad experiences the second highest of 0.2348, on third place comes R&D investment with a correlation with exporting of 0.1934, while the other innovation variables are considerably less correlated with exporting. The correlations between

these innovation variables and exporting remain important after applying propensity score matching in order to correct for selection bias. For the five Latin American countries overall internationalization has an important effect on firms' investment in R&D as well, confirmed by both models, while for some individual countries this is not confirmed by the results.

On the contrary, there is a mostly insignificant impact of internationalization on the probability of acquiring patents in the domestic country, being significant in the first model and slightly so in the second model but only for the aggregate data while still being rather small. On the country level, it could be seen that the only significant result is a negative one reflecting the long-term impact of internationalization on patents of Chilean firms in their country. This result could be explained as the effect from a decision of firms to focus their efforts and investments on their international activities in ways such as adopting international certificates and patents and becoming less concerned with their domestic position. Another explanation could be that firms consider international patents (especially if obtained in developed countries) as superior and protecting their intellectual property rights better hence they prefer focusing their efforts there.

Internationalization has almost no significant impact on the cooperation of the firms with other enterprises and institutions. This conclusion is drawn based on the results showing that the average treatment effects for this innovation variable are insignificant for most countries and while the ATT for the aggregate data is significant in the first model while still being quite small and negligible in the second model it completely loses its significance. Hence, the few significant results are country-specific results rather than region-wide generalizable results. For instance, in Argentina, internationalization leads to a .188 higher probability of cooperation on innovation and this result is in line with Raffo, Lhuillery and Miotti (2008) who reach the conclusion that innovative networking in particular between academic research and private firms is difficult in developing countries, but in countries such as Argentina there is a very positive effect of cooperation with international partners on innovation. (Raffo, Lhuillery & Miotti ,2008).

For the five Latin American countries taken together exporting has a significant impact on six out of the seven innovation variables in the first model and looking at the effect of internationalization on the innovation performance of Latin American firms four years after starting to export internationalization still has significant positive effects on five out of the seven innovation variables. With the exception of very few negative causal effects, all the other significant effects founds for both models are positive. That means that the hypothesis of learning by exporting is confirmed at least to some extent and these

effects are still being accumulated years after the initial exporting. Those results confirm the ones presented in the Latin American Economic Outlook of 2013 where the study reports that in many countries, including Latin American countries exporting companies have a higher probability of engaging in innovation activities overall, with Argentinian exporting firms having 15% higher probability, Chilean – 11% and Colombian – 7%(OECD, 2013).

Further research pursued on this topic would be useful in order to identify any differences in the impact of internationalization on innovation according to the main destination of exports. Moreover, implementing this research relying on data that could provide continuous innovation variables instead of binary innovation outcomes would be very important. Accounting also for the problem of missing data in this panel dataset, executing such a research based on more precise data would be crucial in determining the significance of the obtained results. Finally, numerous explanations could be could be found for the fact that internationalization leads to an improvement of several innovation indicators while in most of the cases having an insignificant impact on product innovation no matter whether in the industry or in the establishment. Despite this lack of direct impact of internationalization on the two variables showing product innovation for most countries (although the impact on the aggregate data is significant on the 1% level), internationalization might still have an indirect impact on this innovation variable in each country through R&D investment. As Raffo, Lhuillery & Miotti (2008) conclude R&D intensity affects product innovation. The increase in R&D investment and intensity due to internationalization may lead to product innovation as a secondary effect. Hence a research into the secondary effects of internationalization on innovation has to be conducted that reveals whether internationalization leads to significantly positive effects on product innovation but also cooperation on innovation through the highly significant positive impact it has on acquiring international quality certificates and international patents, and, most importantly, through R&D investment.

## Appendix A: Data

**Table 1: Number of firms interviewed during 2006 and 2010 broken down by country**

| | Mexico | Colombia | Argentina | Peru | Chile | Total |
|---|---|---|---|---|---|---|
| Number of firms interviewed only in 2006 | 1,270 | 694 | 565 | 318 | 587 | **3,434** |
| Number of firms interviewed only in 2010 | 1,270 | 636 | 556 | 686 | 603 | **3,751** |
| Number of firms interviewed in both 2006 and 2010 | 210 | 306 | 498 | 314 | 430 | **1,758** |
| Total number of observations | 2,960 | 1,942 | 2,117 | 1,632 | 2,050 | **10,701** |

**Table 2: Number of interviewed firms according to exporting status broken down country and year**

| Year | | | Mexico | Colombia | Argentina | Peru | Chile | Total |
|---|---|---|---|---|---|---|---|---|
| **2006** | **Exporting** | **Exporting firms** | **186 (12.6%)** | **242 (24.2%)** | **486 (45.72%)** | **212 (33.54%)** | **273 (26.84%)** | **1,399 (26.95%)** |
| | | Non exporting firms | 1,294 | 758 | 577 | 420 | 744 | 3,793 |
| | | Total number of answers | 1,480 | 1,000 | 1,063 | 632 | 1,017 | 5,192 |
| **2010** | **Exporting** | **Exporting firms** | **431 (29.12%)** | **360 (38.22%)** | **486 (46.11%)** | **612 (61.2%)** | **319 (30.88%)** | **1,984 (36.01%)** |
| | | Non exporting firms | 1,049 | 582 | 568 | 388 | 714 | 3,525 |
| | | Total number of answers | 1,480 | 942 | 1,054 | 1,000 | 1,033 | 5,509 |

*Between brackets the percentage of firms exporters as a percentage of the total number of respondents*

**Table 3: Exporting as percentage of overall sales of companies during 2006 and 2010**

| Year | | Mexico | Colombia | Argentina | Peru | Chile | Total |
|---|---|---|---|---|---|---|---|
| **2006** | **% exporting as a share of overall sales** | 43.13% | 29.55% | 25.53% | 43.82% | 27.96% | **31.84%** |
| **2010** | **% exporting as a share of overall sales** | 27.99% | 23.26% | 24.45% | 38.43% | 27.88% | **28.29%** |

**Table 4: Descriptive statistics of variables of interest**

| Variable | Description | Min | Max |
|---|---|---|---|
| **Internationalization variables** | | | |
| **Exports** | 1 if the exports contribute to the firm's sales , 0 otherwise | 0 | 1 |
| **Innovation variables** | | | |
| **R&D investment** | 1 if the firm has invested in R&D development, 0 otherwise | 0 | 1 |
| **Patents abroad** | 1 if the firm possesses patents abroad, 0 otherwise | 0 | 1 |
| **Patents in domestic country** | 1 if the firm has patents in Mexico, 0 otherwise | 0 | 1 |
| **International Quality Certificates** | 1 if the firm has international quality certificates, 0 otherwise | 0 | 1 |
| **Product Innovation in establishment** | 1 if the firm has introduced product innovations within the establishment during the past 3 years, 0 otherwise | 0 | 1 |
| **Product Innovation in industry** | 1 if the firm has introduced product innovations within the industry during the past 3 years, 0 otherwise | 0 | 1 |
| **Cooperation on innovation** | 1 if the firm has cooperated with other institutions or enterprises on innovation during the past 3 years, 0 otherwise | 0 | 1 |
| **Control variables** | | | |
| **Size** | The natural logarithm of the number of full-time permanent employees | 0 | 9.997 |
| **Total Factor Productivity** | The residual from a Cobb-Douglas function | -6.43 | 8.59 |
| **Foreign ownership** | 1 if 25% or more of the firm is owned by private foreign individuals, 0 otherwise | 0 | 1 |

**Table 5: Correlations of the variables of interest**

| Variable | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Internationalization variable** | | | | | | | | | | | |
| **1.Exports**[8] | | | | | | | | | | | |
| **Innovation variables** | | | | | | | | | | | |
| **2.R&D investment** | 0.1934 | | | | | | | | | | |
| **3.Patents abroad** | 0.2348 | 0.1138 | | | | | | | | | |
| **4.Patents in dom country** | 0.0732 | 0.1243 | 0.3527 | | | | | | | | |
| **5.Intern qual cert** | 0.3924 | 0.1804 | 0.2156 | 0.1213 | | | | | | | |
| **6.Prod inn in establish** | 0.0490 | 0.1384 | 0.0901 | 0.0876 | -0.0016 | | | | | | |
| **7.Prod inn in industry** | -0.0169 | 0.1532 | 0.0375 | 0.0844 | 0.0297 | 0.3423 | | | | | |
| **8.Coop on innovation** | 0.1286 | 0.2315 | 0.0925 | 0.0620 | 0.1772 | 0.1143 | 0.1089 | | | | |

[8] The variable exports is calculated first as a numerical variable by taking 100% minus national sales as a percentage of overall sales and after that it has been transformed into a binary dummy variable {0,1} in order to be appropriate for a probit model. The results reported here are for the dummy variable exports.

**Table 4: Correlations of the variables of interest** *(continued)*

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Control variables** | | | | | | | | | | | |
| **9.Size**[9] | 0.4446 | 0.1996 | 0.2823 | 0.1819 | 0.4882 | 0.0057 | -0.0016 | 0.1215 | | | |
| **10.TFP** | 0.1372 | 0.0020 | 0.1403 | 0.0919 | 0.1865 | -0.0538 | -0.0778 | 0.0185 | 0.0845 | | |
| **11.Foreign ownership**[10] | 0.2540 | 0.0323 | 0.2551 | 0.0662 | 0.2847 | -0.0213 | -0.0534 | 0.0128 | 0.3305 | 0.1950 | |

*Note:* The correlations presented are only for the aggregate data for the five countries.

The data is based on surveys that contain a large amount of missing data and "don't know" answers that have been counted as missing data as well and consequently omitted in the calculations just like the other missing answers. In the database the answers were automatically coded as -9 – "don't know", 1 – "yes", 2 – "no". These variables have been adjusted in such a way so that 1 reflects the answer "yes" and 0 corresponds to the answer "no".

[9] The variable size is calculated by taking the natural logarithm of the number of full-time employees.

[10] The variable foreign ownership is transformed into a dummy variable by assuming that any foreign ownership of the company less than 25% is equal to 0 and foreign ownership above 25% percent is equal to 1.

## Appendix B: Estimations of the production function

**Table 1: Historical exchange rates by country**

| Exchange rate | Mexico | Colombia | Argentina | Peru | Chile |
|---|---|---|---|---|---|
| 2006 | 10.90MXN/$ | 2,361.14COP/$ | 3.05 ARS/$ | 3.27PEN/$ | 530.28CLP/$ |
| 2010 | 12.64MXN/$ | 1,898.57COP/$ | 3.90 ARS/$ | 2.83PEN/$ | 510.25CLP/$ |

*Data from World Development Indicators, the World Bank*

**Table 2: Results from a Cobb-Douglas production function**

| Model for dependent variable: Output | Mexico | Colombia | Argentina | Peru | Chile | Total for all LA5 |
|---|---|---|---|---|---|---|
| Constant | **5.694** | **4.670** | **7.747** | **5.640** | **3.98** | **8.237** |
| Logarithm of capital | **.295** (0.000) | **.267** (0.000) | **.201** (0.000) | **.359** (0.000) | **.353** (0.000) | **.084** (0.000) |
| Logarithm of number of employees | **.959** (0.000) | **.969** (0.000) | **.966** (0.000) | **.838** (0.000) | **.884** (0.000) | **1.165** (0.000) |
| R squared | **0.7810** | **0.7636** | **0.7851** | **0.7755** | **0.7755** | **0.7357** |
| Observations | 1949 | 1154 | 1023 | 862 | 1122 | 6110 |

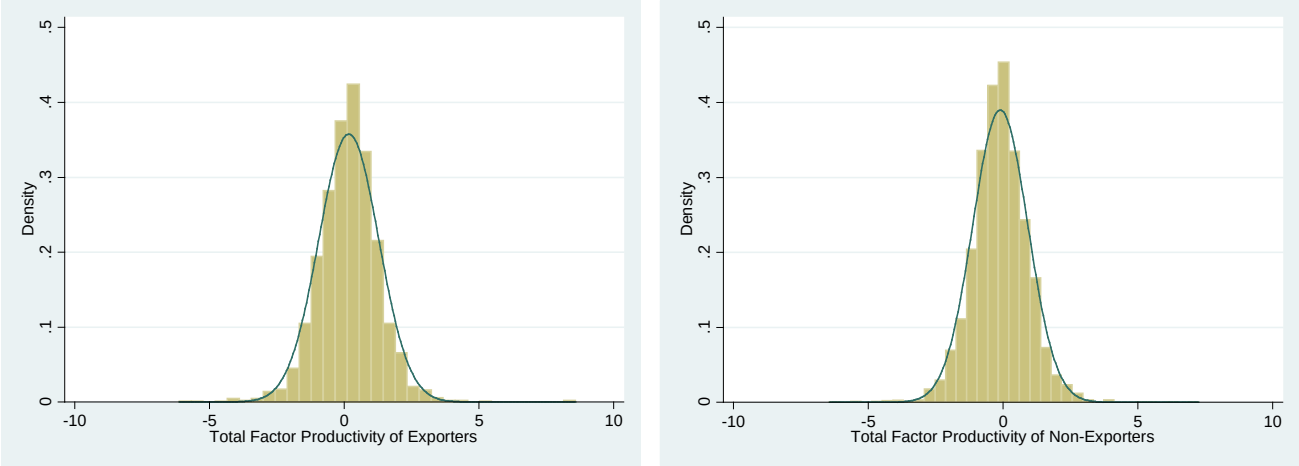
*p-values reported between brackets.*

**Table 3: Mean total factor productivity of firms according to their exporting status broken down by country**

| | | Means for Total Factor Productivity | | | | | |
|---|---|---|---|---|---|---|---|
| | | Mexico | Colombia | Argentina | Peru | Chile | **Total** |
| **Exporting** | Exporters | .168 | .075 | .127 | .050 | .167 | **.173** |
| | Non-exporters | -.056 | -.045 | -.143 | -.045 | -.083 | **-.101** |

*Notes:* The total TFP for LA5 is estimated based on the aggregate data for all countries taken together.

**Figure 1: Total factor productivity frequency distribution for exporters and non-exporters**




It could be seen that the non-exporters are experiencing a slightly steeper curve that reaches its highest point closer to.04 than the exporters. Non-exporters also experience a slightly lower standard deviation of 1.023 compared to 1.115 for the exporters, which means that the TFP of exporters is varing more than the one of non-exporters.

## Appendix C: Robustness of results

**Table 1: Bias before and after matching on the probability of exporting**

| Control variables | % bias | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Mexico** | | **Colombia** | | **Argentina** | | **Peru** | | **Chile** | | **Total (for LA5)** | |
| | **U** | **M** | **U** | **M** | **U** | **M** | **U** | **M** | **U** | **M** | **U** | **M** |
| Size | 119.2% | 3.8% | 107.7% | 3.6% | 87.5% | -5.4% | 104.6% | 9.2% | 118.8% | -7.6% | **101.1%** | **3.5%** |
| Foreign ownership | 61.6% | -8.6% | 47.0% | -11.2% | 53.5% | 16.1% | 47.9% | -20.8% | 54.4% | 23.3% | **52.0%** | **0.9%** |
| Total Factor Productivity | 21.8% | -5.9% | 12.3% | -13.5% | 30.9% | -3.2% | 5.7% | -2.5% | 27.8% | 5.3 % | **25.6%** | **-1.7%** |

*The % bias in matched and unmatched observations is not reported for the dummy variables representing year and country (only applicable in the aggregate data).*

**Table 2: Bias reduction after matching on the probability of exporting**

| Control variables | % reduction in bias | | | | | |
|---|---|---|---|---|---|---|
| | **Mexico** | **Colombia** | **Argentina** | **Peru** | **Chile** | **Total (for LA5)** |
| Size | 96.8% | 96.7% | 93.8% | 91.2% | 93.6% | **96.6**% |
| Foreign ownership | 86.1% | 76.1% | 69.9% | 56.7% | 57.1% | **98.3**% |
| Total Factor Productivity | 72.8% | -9.3% | 89.6% | 56.8% | 80.8% | **93.2**% |

*The % reduction in bias is not reported for the dummy variables representing year and country (only applicable in the aggregate data).*

## Appendix D: Two-time period propensity score model

**Table 1: Probability of becoming exporters (probit model)**

| Control variables | Mexico | Colombia | Argentina | Peru | Chile | Total |
|---|---|---|---|---|---|---|
| **Size** | .383*** | .553*** | .433*** | .329*** | .620*** | **.457*** ** |
| **Foreign ownership** | .938*** | .411 | .757*** | .695** | .563** | **.751*** ** |
| **Total Factor Productivity** | .019 | .047 | .246*** | .025 | .185*** | **.091*** ** |
| *Pseudo $R^2$* | *0.2373* | *0.1739* | *0.1702* | *0.1100* | *0.2266* | *0.2401* |
| *Number of obs* | *907* | *583* | *500* | *283* | *495* | *2768* |

*Notes*: The propensity score matching is implemented with the default properties of psmatch2 command so with replacement.
* The coefficient is statistically significant at the 10% level
** The coefficient is statistically significant at the 5% level
*** The coefficient is statistically significant at the 1% level

| Control variables | % bias | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Mexico** | | **Colombia** | | **Argentina** | | **Peru** | | **Chile** | | **Total (for LA5)** | |
| | **U** | **M** | **U** | **M** | **U** | **M** | **U** | **M** | **U** | **M** | **U** | **M** |
| Size | 115.2% | 16.4% | 100.8% | 5.7% | 89.9% | 6.5% | 73.7% | -0.4% | 116.2% | 9.0% | **92.3%** | **5.2%** |
| Foreign ownership | 81.5% | -11.9% | 21.3% | 22.5% | 46.7% | 5.7% | 41.8% | 4.8% | 43.8% | 4.8% | **45.6%** | **1.6%** |
| Total Factor Productivity | -6.5% | 16.5% | -5.1% | 8.0% | 29.9% | -19.0% | 16.1% | 13.7% | 27.3% | -30.9% | **15.1%** | **-7.9%** |

| Control variables | % reduction in bias | | | | | |
|---|---|---|---|---|---|---|
| | **Mexico** | **Colombia** | **Argentina** | **Peru** | **Chile** | **Total (for LA5)** |
| Size | 85.8% | 94.4% | 92.7% | 99.4% | 92.3% | 94.4% |
| Foreign ownership | 85.3% | -5.4% | 87.8% | 88.4% | 88.9% | 96.4% |
| Total Factor Productivity | -151.7% | -57.8% | 36.5% | 15.3% | -13.2% | 47.3% |

## Appendix E: *Extension: International Licensed Technology*

This section aims at examining the variable international licensed technology. Although the focus of this paper is on internationalization defined as exporting activity, in this section I examine briefly the adoption of international licensed technology as another internationalization measure although not as important as exporting. Although international technology is usually seen as an innovation variable, in this case it cannot be used as one of the variables defining the innovation performance of the firm since it is licensed from a foreign entity and not the result of an innovation effort from the part of the domestic firms researched. On the other side, this variable is an indicator of the internationalization efforts of the firm and their efforts to work more closely with international companies and enterprises. Although this variable is not regularly used as an internationalization variable in order to study this research question, I consider it because of the spillover effects it could have. This is the process through which adopting international technology could lead to significant impact on the innovation performance and productivity of the company other than the direct impact. As Keller (2004) points out, innovations in one country spread to another through international technology. But this process creates spillover effects in research which leads to an increase in the productivity and intensity of the research in the country using the international technology (Keller, 2004). But this macroeconomic effect is the result of an increase in the productivity and intensity of the research on the firm level.

In order to research this variable the basic propensity score matching method used throughout the paper for the exporting internationalization variable is applied without making a difference between the two time periods. The justification for using the propensity score method is that in this case the probability of self-selection bias is high as in the case of exporting. This is confirmed by the results of the probit model presented in Table 4 below.

**Table 1: Number of interviewed firms according to usage of international licensed technology broken down by country and year**

| Year | | | Mexico | Colombia | Argentina | Peru | Chile | Total |
|---|---|---|---|---|---|---|---|---|
| 2006 | International Licensed Technology | **Firms with ILT** | **112 (10.14%)** | **42 (6.65%)** | **100 (15.36%)** | **38 (10.56%)** | **96 (15.07%)** | **388 (11.46%)** |
| | | Firms without ILT | 993 | 590 | 551 | 322 | 541 | 2,997 |
| | | Total number of answers | 1,105 | 632 | 651 | 360 | 637 | 3,385 |
| 2010 | International Licensed Technology | **Firms with ILT** | **180 (15.68%)** | **85 (12.11%)** | **146 (18.6%)** | **110 (14.47%)** | **139 (17.94%)** | **660 (15.83%)** |
| | | Firms without ILT | 968 | 617 | 639 | 650 | 636 | 3,510 |
| | | Total number of answers | 1,148 | 702 | 785 | 760 | 775 | 4,170 |

*Between brackets the percentage of firms using international licensed technology as a percentage of the total number of respondents*

**Table 2: Means of innovation variables for firms using and non-using international licensed technology**

| Innovation variables | R&D investment | Patents abroad | Patents in domestic country | International Quality Certifications | Prod innovation w/n establishment(last 3y) | Prod innovation w/n industry(last 3y) | Cooperat on innov with other enterprises/institute(last 3y) |
|---|---|---|---|---|---|---|---|
| Firms with ILT | .65 | .27 | .55 | .53 | .65 | .61 | .31 |
| Firms without ILT | .46 | .078 | .39 | .22 | .51 | .55 | .19 |

Data from Enterprise Surveys, the World Bank Group [1]

**Table 3: Mean total factor productivity of firms according to their exporting status broken down by country**

| | | Means for Total Factor Productivity | | | | | |
|---|---|---|---|---|---|---|---|
| | | Mexico | Colombia | Argentina | Peru | Chile | **Total** |
| **International Licensed Technology** | Using | .195 | .391 | .271 | .339 | .095 | **.311** |
| | Not using | -.028 | -.040 | -.052 | -.048 | -.018 | **-.047** |

*Notes:* The total TFP for LA5 is estimated based on the aggregate data for all countries taken together.

The same result could be observed as the one for the means of firms distributed according to their exporting status. The firms that use international technology in all five Latin American countries taken together exhibit significantly higher probability of innovating according to all seven innovation variables. In addition, the firms using international technology also have a higher and strictly positive TFP mean in each one of the five researched countries, unlike the non-users that have a negative TFP once again both for each country and for all five countries taken together.

**Table 4: Probability of adopting International Licensed Technology (probit model)**

The model to estimate the probability to adapt international licensed technology looks as follows for each one of the five countries:

$$p(X) = \Pr\big(Exp = 1 \big| X(Size, TFP, For\ own)\big)$$

| Control variables | **Mexico** | **Colombia** | **Argentina** | **Peru** | **Chile** | **Total** |
|---|---|---|---|---|---|---|
| **Size** | .267*** | .247*** | .133*** | .198*** | .325*** | **.240*** ** |
| **Foreign ownership** | .868*** | .821*** | .892*** | .581*** | .659*** | **.763*** ** |
| **Total Factor Productivity** | .079** | .143** | .158*** | .216*** | .027 | **.111*** ** |
| *Pseudo $R^2$* | *0.1665* | *0.1478* | *0.1090* | *0.1081* | *0.1292* | *0.1379* |
| *Number of obs* | *1935* | *1152* | *1019* | *862* | *1119* | *6087* |

*Notes*: Year dummies included, but industry and region dummy variables not included because of very low significance. Year dummies are consistently applied in the models for every country although they have a low significance and their coefficient is not presented here but it affects the coefficients of the other variables presented here.
Country dummies included for the aggregate data.
The propensity score matching is implemented with replacement as set by default in the psmatch2 command.
The balancing property of the propensity score is satisfied for Peru and Chile only.
* The coefficient is statistically significant at the 10% level
**The coefficient is statistically significant at the 5% level
*** The coefficient is statistically significant at the 1% level

All explanatory variables are significant on the 1% level with the exception of TFP for the case of Chile which is not significant and the case of TFP for Colombia and Mexico, where it is significant on the 5% level. The adjusted $R^2$ in the range of 0.1081 to 0.1665 is not as high as the one achieved for the exporting probit model, but this result seems acceptable for this type of model.

**Table 5: Results for the causal effect of adopting international licensed technology on innovation (ATT)**

| Innovation variable | Mexico | Colombia | Argentina | Peru | Chile | Total |
|---|---|---|---|---|---|---|
| **R&D investment** | -.013 | .030 | .151** | .05 | .176** | **.113*** ** |
| **Patents abroad** | .135** | .121 | .065 | -.013 | .048 | **.122*** ** |
| **Patents in dom country** | .115 | .119 | .237*** | .013 | .121 | **.139*** ** |
| **International Qual Cert** | .059 | .121* | .037 | .087 | .099 | **.052** ** |
| **Cooperation on Innov** | .110* | .138 | .032 | -.05 | .139 | **.064*** |
| **Prod inn in estab** | -.043 | .127 | .037 | 0 | .089 | **.106** ** |
| **Prod innov in industry** | -.096 | .308** | .105 | 0 | .014 | **.049** |

*Notes:* Implemented through psmatch2 command in Stata (Leuven & Sianesi, 2015) for retrieving the average treatment effect based on nearest neighbor matching. The ATT is determined by executing the psmatch2 command for every single outcome and not for all outcome variables at the same time. The significance level is determined through bootstrapping with 50 replications.

* The coefficient is statistically significant at the 10% level

**The coefficient is statistically significant at the 5% level

*** The coefficient is statistically significant at the 1% level

It could be seen that although the average treatment effects on the treated obtained for the aggregate data have some statistically significant impact on the innovation levels of the firms, they are in most cases not important on the country level. Moreover, since the ATTs calculated are much smaller than the ones calculated for exporting, this leads to the conclusion that adoption of international licensed technology is not as important factor influencing the innovation of firms as exporting. For these reasons, this internationalization variable is not part of the main research, but the results from it still deserve attention hence are presented here.

**Table 6: Bias before and after matching on the probability of using international licensed technology**

| Control variables | % bias | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Mexico** | | **Colombia** | | **Argentina** | | **Peru** | | **Chile** | | **Total (for LA5)** | |
| | **U** | **M** | **U** | **M** | **U** | **M** | **U** | **M** | **U** | **M** | **U** | **M** |
| Size | 66.8% | -7.9% | 85.7% | -10.5% | 48.5% | -5.6% | 68.1% | -10.9% | 82.6% | -7.8% | **81.3%** | **-0.1%** |
| Foreign ownership | 69.7% | 8.8% | 82.6% | 8.1% | 68.6% | 2.7% | 57.2% | 13.4% | 55.5% | 15.1% | **67.0%** | **3.8%** |
| Total Factor Productivity | 22.4% | 6.8% | 50.7% | 16.4% | 50.6% | 4.0% | 37.5 | 3.4% | 11.6% | 1.2% | **32.7%** | **-5.4%** |

**Table 7: Bias reduction after matching on the probability of using international licensed technology**

| Control variables | % reduction in bias | | | | | |
|---|---|---|---|---|---|---|
| | **Mexico** | **Colombia** | **Argentina** | **Peru** | **Chile** | **Total (for LA5)** |
| **Size** | 88.2% | 87.8% | 88.5% | 84.0% | 90.6% | **99.8%** |
| **Foreign ownership** | 87.3% | 90.2% | 96.0% | 76.5% | 72.8% | **94.4%** |
| **Total Factor Productivity** | 69.7% | 67.7% | 92.2% | 90.8% | 89.3% | **83.6%** |

Examining the robustness of the probit model for international technology shows that there is a significant reduction in observed bias for each one of the variables included in the model. The reduction in bias on the aggregate is very significant reaching the 99.8% for the variable size.

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