
**Universidad de San Andrés**

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**Maestría en Economía**

# *The impact of Quality Certifications on firms' performance. A Random Forest Diff-in-Diff approach*

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# "El impacto de las Certificaciones de Calidad en el desempeño de las empresas. Una evaluación que combina Random Forest y Diferencias en Diferencias"

Resumen

*Este estudio evalúa el impacto de la adopción de certificaciones de calidad internacionales (QC) en el desempeño de las empresas. Utilizando un panel de 4.668 empresas de América Latina y el Caribe, seguimos una estrategia de identificación de dos etapas: (i) Mediante el algoritmo Random Forest, estimamos la probabilidad de que una empresa adopte QC , y (ii) utilizamos las probabilidades estimadas para evaluar el impacto de las QC mediante diferencias en diferencias ponderadas. Nuestros hallazgos indican que adquirir una QC tiene un efecto positivo en el comportamiento exportador de las empresas. Curiosamente, encontramos que este efecto está impulsado por un aumento en el margen tanto intensivo como extensivo de las exportaciones indirectas. Las QC también ayudan a disminuir las restricciones en el acceso a la financiación, pero no se encontró ningún efecto sobre las ventas locales y varias medidas de la productividad de la empresa. Sin embargo, nuestro análisis revela que los impactos positivos de las QC dependen del tamaño de la empresa: solo benefician a las empresas pequeñas y medianas. Esta evidencia puede ser consistente con la idea de que la adopción de QC en los países en desarrollo contribuye principalmente al crecimiento de las pequeñas empresas en las cadenas globales de valor vía reducción de asimetrías de información.*

Palabras clave: Certificaciones de Calidad, Empresas, Evaluación de Impacto, Asimetrías de Información.

# “The impact of Quality Certifications on firms' performance. A Random Forest Diff-in-Diff approach”

Abstract

*This study evaluates the impact of internationally recognized quality certification (QC) adoption on firms' performance. Using a panel dataset of 4,668 firms from Latin America and the Caribbean we follow a two-stage identification strategy: (i) We estimate firms' probability of QC adoption using Random Forest algorithm, and (ii) we use the estimated probabilities for applying a weighted Diff-in-Diff approach. Our findings show that acquiring a QC has a positive effect on firm export behavior. Interestingly, we find that this effect is driven by an increase in both the intensive and extensive margin of indirect exports. QC also helps to ease constraints in access to finance but no effect was found on Local Sales and various measures of firm productivity. However, our analysis reveals that positive impacts of QC on firms' performance are contingent on firm size: it only benefits small enterprises. This evidence may be consistent with the idea that QC adoption in developing countries contributes mainly to the growth of small enterprises in supply chains by reducing information asymmetries.*

Keywords: Quality certification, information asymmetry, impact evaluation, firm performance, panel data, Latin America and the Caribbean.

Códigos JEL: C14, C15, C40, D22, D82, L15

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# 1 Introduction

The Latin America and Caribbean (LAC) is a developing, middle-income region that has managed to raise its per capita GDP over the last quarter century. However, the gap between LAC and developed countries in terms of income and well-being has yet to be bridged. Crespi *et al.* (2014) find that this situation is not due to relatively smaller increases in the levels of physical or human capital, but rather to the productivity gap, which has been growing in recent decades.[1]

There are a number of explanations for this productivity gap. From a macroeconomic standpoint, severe and persistent economic instability in many LAC countries has discouraged long-term investment. This situation is aggravated by the preponderance of small and medium enterprises (SMEs), whose productivity gap with firms in developed countries is even greater. From a microeconomic perspective, the region has failed to correct certain market failures, such as information asymmetries. Typically, owners or managers of a firm know more about their internal operations and future prospects than external agents - i.e. investors, customers, or creditors - can know. This information asymmetry can translate into severe barriers for firm's growth and often generates additional costs.

Additionally, the emergence in last decades of products from low-wage countries created new challenges for firms in LATAM, especially for those that produce in tradable sectors. They had to compete, both in local and foreign markets, with cheaper products. Therefore, most of them had to redesign their business strategy. On the one hand, they could make production improvements to reduce the cost of their products and compete. On the other hand, firms could raise the quality of their products and process to differentiate from competitors so they can compete without reducing their prices.

However, even when firms make quality improvements, they may not be directly observable by their customers or it can be costly to verify. To mitigate the costs of information asymmetry, firms need to seek mechanisms to demonstrate their desirable

[1] For this reason, many productive development policies (PDPs) has been recently supported in LAC. Recently, some of them have been rigorously evaluated. These include innovation policies (Crespi *et al.*, 2015) and their spillovers (Castillo *et al.*, 2016b), cluster development (Figal Garone *et al.*, 2015; Figal Garone & Maffioli, 2016), regional industrial policy (Castillo *et al.*, 2017), technical assistance for SMEs (Castillo *et al.*, 2016a), and scientific research funds (Benavente *et al.*, 2012), among others.

characteristics that are not easily observable by all agents. Quality standard certifications are effective for this purpose and represent a widely accepted solution, as they provide a guarantee that the firm implements high-quality business and manage practices. King *et al.* (2005) argue that managerial standards, such as those granted by the International Organization for Standardization, enable firms to demonstrate characteristics that are not typically observable by third parties.

Firms that obtain an internationally-recognized quality certification tend to have more desirable characteristics than those that do not (Ullah, 2014). It is unclear, however, whether this relationship is causal, or whether firms deciding to adopt this certification, for example, are already close to (or have surpassed) the quality threshold required to obtain it. In any case, firms can use this certification as a mark of quality to address the information asymmetry between them and the external agents with whom they interact. For the purpose of this study, we classified these agents into three groups: (i) domestic customers, for whom the certification is a guarantee that the firm complies with certain quality standards; (ii) foreign customers, with whom greater information problems arise, and therefore who are more demanding with respect to process and product quality standards, which increases the importance of certification; and (iii) financial institutions, which through the certification, also receive relevant information by the certification about the firm's economic situation and good business practices, thereby improving its credit risk assessment.

In this paper we analyze the role of acquiring international certification on removing informational barriers that hinder firm's development and growth. First we describe the firms in LAC that obtained an internationally-recognized quality certification [2]. Then we explore the effects of this certification on several variables of firm performance. The evidence on the impact of acquiring a quality certification on firm performance is scarce and it is specially important to firms in developing countries (as Latin America and Caribbean) where information asymmetries are larger and firms' growth were slow. We argue that analyzing several outcomes is important not only to understand the impact in different firm-level dimensions, but also because each outcome is related to a different external agent of the firm. Therefore, it allows us to explore why firms certificate and, at the same time, identify for which agents the quality certification really matters as signaling mechanism of relevant characteristics of the firm.

We use the World Bank Enterprise Survey (WBES) carried out in Latin America

[2] We focus on process certification, such as ISO 9000 certificates.

in 2006 and 2010 (with the exception of Brazil, where it was conducted from 2003 to 2009), and the LACES carried out in 2011, in combination with the new round carried out in 2014 (PROTEqIN) for Caribbean countries. Of 22,945 enterprises who were surveyed, we use a subset of 4,668 firms from 27 LAC countries who were surveyed in two years and allow us to construct a panel database. Our identification strategy for the impact of quality certification is a weighted difference-in-difference approach, which allows us to deal with potential endogeneity issues. Weights are introduced in order to conduct a double-robust evaluation assuring that treated and control groups' covariates are equal in mean at baseline. To avoid biased conclusions due to weights misspecification we estimate two alternative Inverse Probability Weights, one using the traditional Probit model, and the other using the non-parametric random forest algorithm firstly proposed in Breiman (2001).

Our main findings are that QC do generate positive effects on exports. Furthermore, QC helps to ease constraints in access to finance. Conversely, no effect was found on Local Sales and various measures of firm productivity[3]. When we analyze the effects in more depth, the results are striking in two respects. First, we find that the effect on exports is driven by an increase in both the intensive and extensive margins of indirect exports. That is, QC increases the volume of exports and promotes firms to start exporting, but only indirectly through other firms already conducting direct exports. Second, our analysis reveals that positive impacts of QC on firms' performance are contingent on firm size: it only benefits small enterprises. This evidence may be consistent with the idea that QC adoption in developing countries contributes mainly to the growth of small enterprises in supply chains by reducing information asymmetries.

To test the robustness of our results, we perform two falsification tests using those firms that initiated a quality certification process but not received it yet and also those firms that based on observed covariates are closer to treated ones[4]. The fact that no significant effects were found in falsification tests supports our previous findings.

The paper is organized as follows: Section 2 contains a review of the literature on quality certification adoption and its effects. Section 3 presents the data and variables used, describes the sample and shows the differences in the variables between firms

[3] However, the time window we analyze may be not enough to see long term improvements. We discuss this point on section 5

[4] We employed the Genetic-Matching (Diamond & Sekhon, 2013) algorithm to find the nearest-neighbours of treatment group and falsified them as treated

that adopt international standards and those that do not. Section 4 details our identification strategy and presents the results of the first stage for baseline covariates' mean balance. Section 5 analyzes the impact of adopting international standards on firms' local sales, export bahavior, finance restriction, and productivity. Section 6 assess the robustness of the results using falsification tests. Section 7 concludes and offers some final considerations.

## 2 Literature Review

Firms that seek to obtain an international quality certification (e.g., ISO standards) must ensure that they are implementing best business practices by establishing a quality policy with measurable objectives, complying with certain requirements concerning customer satisfaction, and providing the necessary training for staff to reach the required level of competence, among other activities. Several studies showed that the adoption of those modern practices are an important determinant of firms' growth (Syverson, 2011; Bloom *et al.*, 2013, 2019). Additionally, Bloom *et al.* (2019) showed that the adoption in Developing Countries appears to be relatively scarce.

However, the adoption of quality standard certification may not be directly related to the decision of change the management practices. Hudson & Orviska (2013) developed a model that shows that obtaining international quality certification allow firms to demonstrate higher quality and less uncertainty about their activities and products or services. Therefore, the goal of firms that seeks to improve their managements practices (e.g. raise their productivity and reduce costs) may not be the same goal of firms that looks for certify (e.g. signalling quality to other agents). In particular, firms could make the improvements before they certified for their own interest Terlaak & King (2006).

The empirical literature on the determinants of the adoption of international quality standards and its impact on firm's performance is quite recent. The evidence shows that exporters, larger firms and those with a higher share of foreign ownership are more willing to seek adoption of international quality standards (Pekovic, 2010; Hudson & Orviska, 2013; Fikru, 2014; Ullah *et al.*, 2014). Exporters are more likely to adopt a certification because there is a greater information asymmetry with their foreign customers than their local clients and, in addition, because there is a harder

competition in foreign than local markets. At the same time, larger firms and companies with foreign ownership generally enjoy greater access to financial resources and have superior management, enabling them to achieve certification more readily. In addition, Alfaro-Serrano (2019) shows the cost of the quality certification implies an important barrier to firms and that a subsidy increases the certification probability and induces the adoption of better managerial practices.

The literature about the impact of the adoption of quality certifications on firm's performance has focus on two main variables: exports and productivity. In terms of the literature about the impact of certificate on exports, there are various studies that find significant effects on both the probability of exporting and the volume exported, that is, on both the intensive and extensive margin of trade (e.g., Xiaoyang Chen *et al.*, 2008; Volpe Martincus *et al.*, 2010; Otsuki, 2011; Sun & Outyang, 2014). These findings are important not only in terms of developing the export potential of firms in a given country, but also because there is evidence that firms learn lessons throughout the export process, which enables them to improve their productivity (De Loecker, 2007; Harrison & Rodriguez-Clare, 2010) and profits (Zhang *et al.*, 2019). Quality standards seem to be particularly important for firms in developing countries who suffers from what Zhou & Guillén (2015) has named Foreign Liability, i.e. the general perception of low quality associated with country's low per capita income. Hence, firms seeking to export need an alternative way to show that their products can also be of high quality.

In contrast, findings about the effects of quality certifications on firm's productivity are less conclusive. While there is evidence that certified firms are more productive (Dick *et al.*, 2008; Starke & Rangamonhan, 2012;Ullah *et al.*, 2014; Trifkovic, 2017; Calza *et al.*, 2019)), it is not clear whether firms improve their productivity by obtaining the certification or they obtain the certification because they already are more productive. Javorcik & Sawada (2018) show that ISO 9000 has no effect on labor productivity and average wages on the short run, while there is a significant effect on both variables on the long run. This difference in the timing of the effect reflects that the improvements implemented to certify require maturing time to materialize in a more efficient production process. In addition, after examining data from manufacturing firms in 59 countries, Goedhuys & Sleuwaegen (2013) find a positive impact of quality certifications on firm's total factor productivity and that the effect is greater for the firms located in countries with weaker market institutions. This finding underscores the importance of exploring these issues in the LAC region, where the potential benefits may be considerable.

Finally, the impact of acquiring a quality certification on other outcomes of interest is almost non-existent. In particular, we will focus on the impact on the access to finance. Using the World Enterprise Survey, Ullah *et al.* (2014) shows ISO certified firms exhibit significantly lower level of financial constraints, higher level of exports and productivity. Although the data they used are similar to the one used in this paper, they provide evidence in a cross-section setting for 31 LAC countries and therefore their results rest on the assumption that there is no firm-level unobserved heterogeneity that is not related to both the decision to certify and firm performance.In our case, we exploit firm-level panel data and apply an inverse probability weighted difference-in-difference (IPW-DID) approach that allow us to control for baseline and time-invariant firm heterogeneity. This approach reduce the potential bias caused by selection, since certified and non-certified firms are clearly not similar.

# 3 Data and descriptive statistics

This study is based on the World Bank Enterprise Survey (WBES). The WBES is a firm-level survey of a representative sample of an economy's private sector. The survey covers a broad range of business environment topics including access to finance, corruption, infrastructure, crime, competition, and performance measures. In this paper, we use the WBES carried out in Latin America in 2006 and 2010 (with the exception of Brazil, where it was conducted in 2003 and 2009), and the Latin America Country Enterprise Survey (LACE) carried out in 2011 in combination with the new round carried out in 2014 (PROTEqIN) for Caribbean countries. Overall, data were obtained from 22,945 enterprises in the LAC region. Given that some firms were surveyed in two years, we can construct a panel database for our main estimations. We provide a detailed description of the countries and the number of observations covered by our database in Table 15 in the appendix.

The variables used in this study are described in Table 1. Our main focus is on the variable "Quality certification" that identifies if the firm have an internationally-recognized quality certification (QC). It is used to construct a "treatment variable"[5] which allow us to evaluate the effect of certification on certain outcomes of interest linked to firm performance. For that, we focus on a set of ten main outcome variables to evaluate firm's performance and how they are affected by the acquisition of an internationally-recognized quality certification. First, in order to explore the firm's

[5] The specification of the treatment variable is presented in section 4.1

performance in foreign markets, we focus on the export status of the firm and the amount of exports (total, direct, and indirect). Second, we use local sales to assess firm's performance in national markets. Then, we focus on firm's access to finance (own perception as a barrier). Finally, we use labor productivity and TFP measures to evaluate firm's productivity[6].

Additionally, we use a set of control variables to reduce potential biases. We control for firm's characteristics including firm age, number of employees, management experience and whether firm has foreign owners. As well, we have two variables that are related to activities of the firm, such as whether the firm uses a website to communicate with customers and suppliers; and the percentage of working capital financed by banks.

Table 2 compares the mean values at the baseline survey of outcomes and control variables between firms that achieved a QC and those that did not. For that purpose we classify them into three groups: those firms who never reported having a QC (Column 1), those who hadn't a QC at the baseline survey but has it in the follow-up survey (Column 2), and those firms that already had a QC at the baseline survey (Column 3).

By the mean differences reported in columns 5 and 6 we can say that, in general, firms who have adopted international quality standards tend to perform better. They have greater sales in local markets compared to firms without certification. In terms of international insertion, 52% of certified firms are exporters, whereas only between 23% and 30% of non-certified firms sell in foreign markets. Moreover, those that manage to get certification export a larger volume, and a higher proportion of their sales. Although this preliminary evidence reveals a clear correlation between export orientation and performance for firms with international certification, it is still not sufficient to attribute causality. For example, it may be the case that firms incorporate knowledge and lessons by exporting that subsequently help them to acquire a certification.

In addition, certified firms have more desirable characteristics as measured by several variables. They tend to hire more employees, between 112% and 70% compared to firms without certification. This is understandable, since firms that have adopted quality standards are more likely to fall in the medium- (between 51 and 200 employees) and large-sized (more than 200 employees) categories, whereas the

[6] We computed productivity using other measures (e.g. value added per employee and measures of TFP using input shares in the total cost) and results remained unchanged

Table 1: Description of variables

| Variable | Definition |
|---|---|
| Quality Certification | Binary variable that takes the value 1 if the firm has an internationally recognized quality certification and 0 otherwise |
| Exporting firm | Binary variable that takes the value 1 if the firm exports 0 otherwise |
| Direct Exporting firm | Binary variable that takes the value 1 if the firm exports directly and 0 otherwise |
| Indirect Exporting firm | Binary variable that takes the value 1 if the firm exports indirectly 0 otherwise |
| Exports | Total amount exported (US dollars) |
| Direct Exports | Total amount exported directly (US dollars) |
| Indirect Exports | Total amount exported indirectly (US dollars) |
| Local sales | Total amount sold in the local market (US dollars) |
| Financial barrier | Binary variable that takes the value 1 if the firm considers access to financing to be a significant or severe barrier and 0 otherwise |
| Labor productivity | Sales per employee (US dollars) |
| TFP | Total factor productivity estimated using the Levinsohn & Petrin (2003) methodology |
| Employees | Number of permanent full-time employees |
| Management experience | Years of management experience in the sector |
| Foreign | Binary variable that takes the value 1 if the firm is own by a private foreign individual/organization in more than 10% |
| Age | Number of years since the business was started |
| Website | Binary variable that takes the value 1 if the firm use a website to communicate with customers or suppliers |
| Bank | Binary variable that takes the value 1 if the firm is financed by banks |

Table 2: Baseline characteristics of firms with and without Quality Certification

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | | Mean | | | Difference | |
| | No QC | QC at $t=1$ | QC at $t=0$ | Columns (2)-(1) | Columns (3)-(1) | Columns (3)-(2) |
| Ln Employees | 3.165 | 3.590 | 4.291 | 0.425*** | 1.126*** | 0.701*** |
| Ln Sales | 12.836 | 13.654 | 14.530 | 0.818*** | 1.694*** | 0.876*** |
| Ln Local Sales | 13.231 | 13.864 | 14.508 | 0.633*** | 1.277*** | 0.644*** |
| Exporter | 0.233 | 0.307 | 0.520 | 0.075*** | 0.288*** | 0.213*** |
| Indirect Exporter | 0.085 | 0.080 | 0.130 | -0.005 | 0.045*** | 0.050*** |
| Ln Exports | 2.896 | 4.113 | 7.426 | 1.217*** | 4.530*** | 3.313*** |
| Ln Indirect Exp. | 1.012 | 0.946 | 1.697 | -0.067 | 0.684*** | 0.751*** |
| Finance | 0.332 | 0.324 | 0.249 | -0.008 | -0.083*** | -0.075*** |
| M. Experience | 18.916 | 18.382 | 20.299 | -0.533 | 1.383*** | 1.917*** |
| Age | 22.283 | 24.406 | 30.931 | 2.124** | 8.649*** | 6.525*** |
| Website | 0.369 | 0.479 | 0.698 | 0.110*** | 0.329*** | 0.219*** |
| Foreign | 0.080 | 0.136 | 0.273 | 0.057*** | 0.193*** | 0.137*** |
| Bank | 0.475 | 0.527 | 0.521 | 0.052* | 0.047** | -0.005 |
| Ln Labor Prod. | 9.671 | 10.065 | 10.239 | 0.393*** | 0.568*** | 0.175* |
| TFP | 1.439 | 1.521 | 1.363 | 0.082 | -0.076 | -0.158* |
| Micro size | 0.242 | 0.168 | 0.075 | -0.074*** | -0.167*** | -0.093*** |
| Small size | 0.499 | 0.439 | 0.279 | -0.060** | -0.220*** | -0.160*** |
| Medium size | 0.202 | 0.225 | 0.357 | 0.023 | 0.155*** | 0.133*** |
| Big size | 0.058 | 0.168 | 0.289 | 0.111*** | 0.231*** | 0.120*** |
| # of Firms | 3,404 | 374 | 890 | 3,778 | 4,294 | 1,264 |

Source: Author's estimates based on WBES, LACES and PROTEqIN.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

non-certified group are mostly micro (less or equal than 10 employees) and small (between 11 and 50) firms. Certified firms are also older, have managers with more years of experience and their owners tend to be foreigners in larger proportions, are more likely to have a website to communicate with their customers and suppliers and finance a greater proportion of their working capital with banks, which is another signal that they have a better access to finance.

However, Column 4 which displays the differences between firms that will certify and those that won't tell us that many of the characteristics we previously described for firms having a QC may be already present even before they get a certification. For instance, firms that will certify are bigger, more export oriented, and have larger sales volume than those who won't certify. Also, differences in labor productivity exist before certification had taken place. This strong self selection may be a source of bias when analyzing the impact of acquiring a QC on firm performance, and it is the reason we use a two-step identification strategy that will be discussed in the next section.

# 4 Identification Strategy

Our identification strategy consists in a two step difference-in-difference estimation from a balanced repeated cross-section of 3,778 firms. In the first step we estimate the propensity score, i.e. the baseline probability of obtaining a quality certification, using two alternative methods: Parametric Probit and Non-Parametric Random Forest. In the second step we use the estimated propensity scores for weighting the diff-in-diff model and estimating the average treatment effect on the treated (ATT). As stated by Wooldridge (2007, p.1293), under regular assumptions this identification strategy has a general "double robustness"[7] property. Hence, our identification assumption is that, conditional on the characteristics in $t = 0$, there is not time-varying unobserved heterogeneity correlating outcomes' trends with firms' decision to certify.

Details of each step are presented next.

[7] This implies that if at least one of the two models is correctly specified, i.e. diff-in-diff or propensity score, then the estimated ATT is consistent.

## 4.1 Setting

To estimate the impacts of interest we set-up a cuasi-experimental framework which allow us to use a difference-in-difference strategy. For that, we define two relevant periods, before treatment ($t = 0$) and after treatment ($t = 1$), and also two relevant groups, *Treatment group* and *Control group*. For each firm, before treatment period corresponds to the baseline survey year and after treatment period corresponds to the follow-up survey year[8]. Furthermore, treatment group is comprised by those firms who had not a *Quality Certification* in $t = 0$ but obtained one before $t = 1$. We can see in Table 4 that 374 firms conform the treatment group. Also, the 3,404 firms conforming the control group is comprised by those firms who had not a *Quality Certification* in $t = 0$ and remain the same in $t = 1$. We exclude from our database, as displayed in table 3, 890 firms who already had a *Quality Certification* in $t = 1$. This reduce our panel from 4,668 firms to 3,778 firms.

Table 3: Quality Certification

| Has Quality Certification | Baseline (t=0) | Follow-Up (t=1) | Total |
|---|---|---|---|
| No | 3778 | 3589 | 7367 |
| Yes | 890 | 1079 | 1969 |
| Total | 4668 | 4668 | 9336 |

Note:Balanced Panel of 4668 firms

Table 4: Treatment Status

| Treated | Before (t=0) | After (t=1) | Total |
|---|---|---|---|
| No | 3778 | 3404 | 7182 |
| Yes | 0 | 374 | 374 |
| Total | 3778 | 3778 | 7556 |

Note:Balanced Panel of 3778 firms

To asses the impact of obtaining a *Quality Certification* on firm performance we use a weighted differences-in-differences (Dif-in-Dif) model. The resulting model is presented in equation 1 :

$$y_{icst} = \beta T_i + f_i + \delta_t + c_c * \delta_t + s_s * \delta_t + \gamma X_{it} + \varepsilon_{icst} \quad ; \quad \lambda_i^m \tag{1}$$

The coefficient $\beta$ represents the effect of adopting the quality certification on any outcome. The variable $T$ takes the value 0 if the firm lacked certification and

[8] Each firm have only one observation by period but baseline survey was collected in year 2003 for Brazil, 2006 for remaining LA countries and 2011 for Caribbean. Follow-up survey for Brazil, LA and Caribbean were respectively conducted in 2009, 2010 & 2014. For details, see Table 15 in the appendix

continues without it, or if it had not acquired a certification yet; it takes the value 1 if the firm was not certified in the previous period, but is now. To endow the model with a Diff-in-Diff structure we use firm-level ($f_i$) and time ($\delta_t$) fixed-effects, and to avoid bias coming from country and sector specific trends we also include Country-Year ($c_c * \delta_t$) and Sector-Year($s_s * \delta_t$) specific trends. Finally, we include a set of firm specific time-varying covariates in $X_{it}$. Since firms in the panel are surveyed in 2 periods, number of observations will double number of firms in all estimations.

The Diff-in-Diff method control for both observable and unobservable heterogeneity between firms that is constant over time (e.g. firm's sector, location, and other firm intrinsic characteristics) which enables a significant reduction of the estimation bias. Nevertheless, the method has some limitations and its causal interpretation relies on treated and control groups satisfying the parallel trend assumption. This assumption may be implausible if pre-treatment characteristics that are thought to be associated with the dynamics of the outcome variable are unbalanced between the treated and the untreated. If that is the case, and pre-treatment characteristics of treatment and control groups are significantly different, then even in the absence of treatment they would perform differently over time. That is why, in order to achieve pre-treatment balanced groups, we adjust the Diff-in-Diff using the weights $\lambda_i^m$ as we explain in the next section. Given that the models implemented to estimate the propensity score, and hence to define weights, are feasible of misspecification leading to biased conclusions, we present results from two alternative methods $m$. The general approach for propensity score estimation and the specific methods we use are detailed next.



## 4.2 Propensity Score Estimation

The Propensity Score (PS) method was first introduced by Rosenbaum & Rubin (1983) as a way for "*balancing*" treatment and control groups on a set of baseline characteristics; i.e., to make the groups as similar as possible with respect to those observed baseline characteristics. The PS itself is defined as the conditional probability of being assigned to the treatment group:

$$Pr(T_i = 1|X_i = x_i) = p_T(x) \tag{2}$$

The most common methods for estimating PS are logit and probit (Imbens &

Wooldridge, 2009). However, there is evidence that slight misspecifications of this kind of parametric propensity score models can result in substantial bias of estimated treatment effects (Drake, 1993; A. Smith & E. Todd, 2005; King & Nielsen, 2019a). In order to address this issue, semi-parametric and non-parametric techniques can be employed for estimating it (Mccaffrey *et al.*, 2005; Li *et al.*, 2008; Imai & Ratkovic, 2014; Busso *et al.*, 2014).

Among non-parametric methods, machine learning (ML) algorithms such as CART, Support Vector Machines and Random Forest are promising alternatives for PS estimation (Westreich *et al.*, 2010; Imbens & Rubin, 2015). Main reason for this is that ML algorithms generally achieve higher classification accuracy by requiring fewer assumptions about functional forms and tuning parameters, characteristics that are especially useful in the presence of non-linearity and non-additivity of confounders (Lee *et al.*, 2010).

We employ two alternative methods for estimating PS, parametric Probit and non-parametric Random Forest (RF). The use of RF, firstly proposed by Breiman (2001), is growing in econometrics and applied economics literature (Imbens & Wooldridge, 2009; Varian, 2014; Duflo *et al.*, 2017; Athey *et al.*, 2019) and is generally recognized for its accuracy and its ability to deal with small sample sizes and high-dimensional feature spaces (Biau & Scornet, 2016, p.1). RF is a generic name for the process of *(i)* aggregating *(ii)* random *(iii)* decision-trees, its three main features:

i Bootstrap aggregating (*Bagging*) consists on drawing $B$ bootstrap samples of size $N$ from the data, constructing a decision-tree for each sample, and averaging results over the B samples. We took $B = 1000$ samples of size $N = 748$ without replacement. Sample size was defined for achieving, in average, size-balanced treated and control groups [9].

ii At each node ($d$) of the decision-tree, $L$ regressors are randomly selected out of $K$ possible covariates. This is a key aspect for RF accuracy because it introduces exogenous variation into the classification process. We employ the

[9] Imbalanced groups between classification dimensions is a serious issue in this kind of algorithms because simple decision rules overestimates the probabilities of belonging to the majority group. In our database, after dropping out 118 firms with perfect treatment predictors (all firms form Belize were in the control group), we have a treatment group of size $N_T = 374$ and control group of size $N_C = 3286$. For achieving size-balance we set a vector assigning sampling-probabilities of $(\frac{1}{N_T}, \frac{1}{N_C})$ for treated and control groups respectively.

same set of $K = 12$ covariates used for Probit estimation and followed the empirical rule of setting $L = \frac{K}{3} = 4$

iii Decision-trees arise from repeated binary splits of the sample, over each regressor $L$ , wich are done in order to maximize the classification accuracy between treated and control group at each node. The split-rule (equation 3) and an example of a Random Decision Tree (fig 1) are presented below:

$$\begin{aligned} MSE(d) &= MSE_{\hat{C}} + MSE_{\hat{T}} \\ &= \sum_{i \in \hat{T}=0} (y_i - \overline{y}_{\hat{T}=0})^2 + \sum_{i \in \hat{T}=1} (y_i - \overline{y}_{\hat{T}=1})^2 \end{aligned} \tag{3}$$

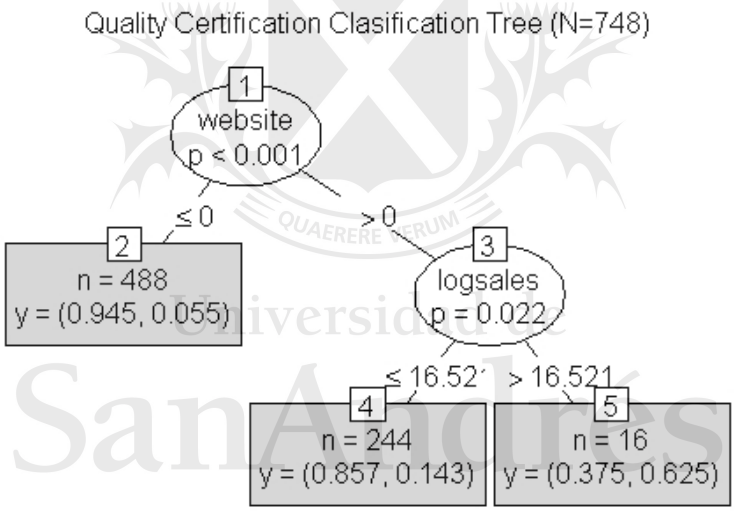


Figure 1: Classification Tree

At each classification node $(1, 3)$, conditional on the value of the regressor, the sample is splitted between firms classified as treated (right) and control (left). The y-vector at each terminal node $(2, 4, 5)$ indicates the proportion of control and treated units respectively.

The resulting PS densities, estimated via Probit[10] and RF, are presented on figures 2 and 3. Due to the superior classification power of RF over Probit, we can realize that RF-PS density of treated and control groups has fewer overlapping over the support than those observed for Probit. Because we don't follow a local PS-Matching strategy, but a complete sample re-weighting, while covariate balancing between treated and control group is satisfied reduced overlapping is not a threat for our identification strategy[11]. On the contrary, given the marked differences of methodology and results between the two competing strategies we propose for estimating the PS, similar results on the estimated treatment effects will be an important proof of robustness. We present the balancing results next.

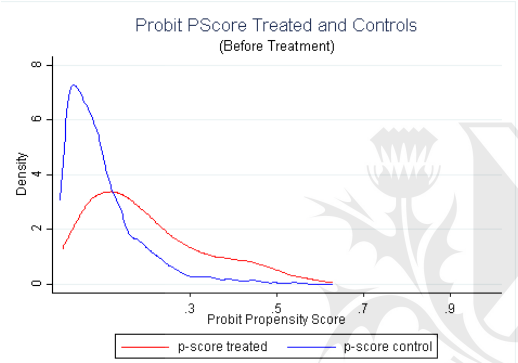


Figure 2: Probit PS Density

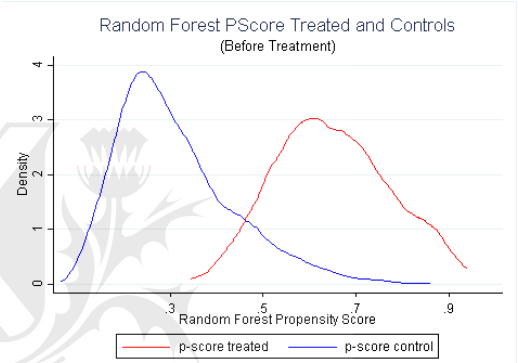


Figure 3: Random Forest PS Density



## 4.3 Inverse Probability Weighting and Balancing results

Inverse Probability weighting (IPW) has a long tradition in statistics and was firstly employed in econometrics for consistent estimation under non-random attrition and censored data (Horvitz & Thompson, 1952; Rubin, 1976; Robins *et al.*, 1995; Robins & Rotnitzky, 1995). The main logic behind this method is that if we weight the observations of a non-random sample using the inverse of its sampling probability, we can reconstruct the sample as if it had been taken at random. The case of selection

[10] Estimated coefficients of the Probit model and the full set of covariates used for both methods are presented in Table 16 in the appendix

[11] We estimate the ATT (average treatment effect on the treated) which according to Imbens (2004) requires two weaker conditions for identification: i) Unconfoundedness for the control trends $E[Y_1(0) - Y_0(0)|X, T] = E[Y_1(0) - Y_0(0)|X]$, and ii) Weak-overlapping $Pr(T_0 = 1|X) < 1$

on the treatment can be seen as a special case of the selection problems described before and hence IPW can be used for reducing bias in the estimation of treatment effects. That was demonstrated by Rosenbaum (1987) and Hirano *et al.* (2003), who respectively proved the consistency and efficiency of IPW for treatment effect estimation.

We use IPW for estimating the average treatment effect on the treated (ATT). ATT requires weighting the control group using the odds-ratio of the estimated propensity score and leaving the treatment group unchanged as showed in equation 4:

$$\lambda_i^m = \begin{cases} 1 & \text{if } T = 1 \\ \frac{\hat{p}_t(X_i)^m}{1-\hat{p}_t(X_i)^m} & \text{if } T = 0. \end{cases} \tag{4}$$

Lee *et al.* (2010) conducted montecarlo simulations evaluating the performance of IPW using parametric and machine learning methods and discovered that random forest was among the best performers in reducing estimation bias of treatment effects[12]. Furthermore, they find that covariate balancing was one the best metrics predicting bias reduction on treatment effect estimations. Results of baseline covariate mean balance before and after weighting are presented in Figure 4[13] and Table 17 in the appendix.



[12] This was especially true for data generating process with non-additivity and non-linearity. For DGP with linear specification parametric methods performed equally well.

[13] Due to space limitations, balance for country and sectors is not presented. Both dimensions were included into both models and a correct balance was achieved after weighting

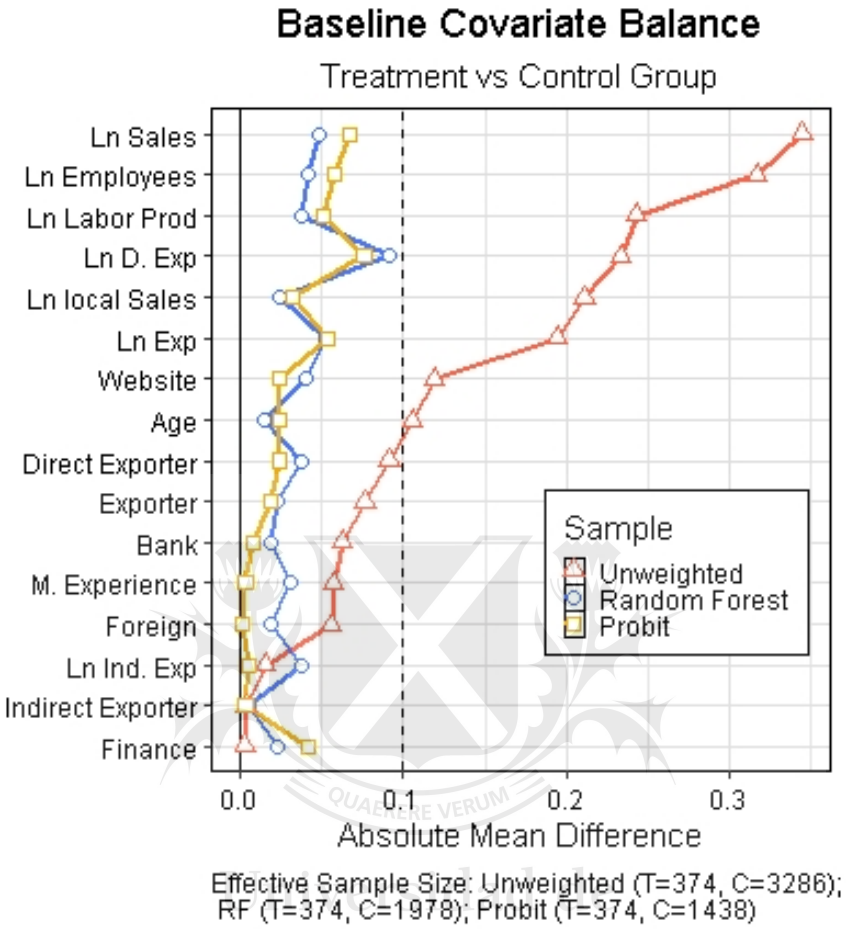


Figure 4: After weighting covariate balancing

In figure 4, it can be seen that firms into the treated group are generally bigger (both in terms of sales and employees), more export oriented, more productive, foreign owned, and have greater probability of having a website. However, after IPW all mean differences between groups are reduced below the 0.1 smd[14] threshold and below significant t-statistic levels as displayed in Table 17 in the appendix. Moreover, although the estimated propensity scores are unalike between methods, both RF IPW and Probit IPW produce similar balancing. These facts increase our confidence in the robustness of the IPW methodology and their effectiveness for reducing bias when combined with DID. The results of the impact evaluation of

[14] Standarized mean difference

Quality Certifications on firm performance are discussed below.

# 5 Impacts on Firm Performance

The analysis of the results is divided into three parts concerning the effects of acquiring an international quality certification over firms' international operations, national operations, and internal operations. First, subsection 5.1 evaluates the impacts of QC on foreign operations by analyzing its effect over the probability that a firm start exporting and also its effect over the volume of exports. Second, subsection 5.2 evaluates the impacts of QC on domestic operations by analyzing its effect over the volume of local sales and also its effect over the probability that firms declares to be financially restricted. Also, because certificated firms introduce new productive processes, management control systems, and implement a staff training agenda during the certification process, increases in productivity may be expected and are analyzed in 5.3 using Labor Productivity and Total Factor Productivity as indicators of firm's internal operations' efficiency. Furthermore, for each subsection we analyze the average treatment effect on the treated (ATT), and the Local-ATT by splitting the effect to evaluate heterogeneous impacts among micro-small firms and medium-big ones.



## 5.1 Export behavior

Firms may seek to signal their quality to customers in international markets or they may be constricted by trading barriers requiring them to certificate their operations. In this case, the impact could be reflected by the firm's entry into foreign markets, either by starting exporting (non-exporting firms) or by expanding exports (already exporting firms). Hence, we estimate the equation 1 using export condition and the amount of exports[15]. Subsection 5.1.1 presents the results for total exports and subsection 5.1.2 do the same but focusing on Direct and Indirect exports

[15] We transform local sales and export volumes using the inverse hyperbolic sine (or arcsinh) transformation. Performing the IHST to a variable approximates the natural logarithm of that variable and allows retaining zero-valued observations ($0 U\$ S$ exports). It was introduced by Burbidge *et al.* (1988). For recent economic applications see e.g. Pence (2006) and Bellemare & Wichman (2019)

separately. Also, each subsection analyses average impact, and local-average impact among micro-small and medium-big firms[16].

### 5.1.1 Effect on Total Exports

Results for the extensive and intensive margins of exports are shown in Tables 5 for average total exports and in table 6 for micro-small and medium-big firms.

Columns 1 and 2 of table 7 show that the average impact of quality certifications over export probability is between 6% and 8% depending on the IPW method we apply (Random Forest or Probit respectively). Furthermore, columns 3 and 4 indicate that QC acquisition increases export volume between 69% and 87%.

In addition, columns 1 and 2 of table 6 show that the effect of increased probability of exporting was mostly concentrated on micro and small firms (between 8% and 11% greater) while for medium and big firms no significant effect was found. The same can be said for the effect of QC over the volume of exports which were only affected positively in a significant way for micro-small firms.



[16] Firms with more than 50 employees or more than $2.6U\$S$ millions in sales are considered medium or big. For defining it we followed 1992 MERCOSUR's criteria adjusting at 2007 prices the sales value limit. For a review on LAC definitions on SMEs please refer to Cardozo *et al.* (2012)

Table 5: Effect of internationally-recognized quality certification on Total Exports

| | (1) Export[1] Probit[3] | (2) Export RF[4] | (3) Ln Exports[2] Probit | (4) Ln Exports RF |
|---|---|---|---|---|
| Treated[5,6,7] | 0.076*** | 0.057** | 0.866*** | 0.694** |
| | [0.024] | [0.026] | [0.309] | [0.343] |
| Observations | 6,950 | 6,950 | 6,392 | 6,392 |
| Mean | 0.311 | 0.296 | 4.179 | 4.002 |
| | [0.463] | [0.457] | [6.339] | [6.257] |
| Firms | 3475 | 3475 | 3196 | 3196 |
| Control | 3121 | 3121 | 2868 | 2868 |
| Treated | 354 | 354 | 328 | 328 |

Source: Author's estimates based on WBES, LACES and PROTEqIN using IPW Diff-in-Diff.
Notes: (1) Export: Probability to start exporting. (2) Ln Exports: IHST Volume of total exports.(3) Probit: Probit IPW. (4) RF: Random Forest IPW. (5) Time varying controls for Foreign ownership, Manager Experience and own Website. (6) Firm-level fixed effects and Country and Sector specific trends included. (7) Clustered standard errors at country-sector-year level in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 6: Effect of internationally-recognized quality certification on Total Exports (By Firmsize)

| | (1) Export[1] Probit[3] | (2) Export RF[4] | (3) Ln Exports[2] Probit | (4) Ln Exports RF |
|---|---|---|---|---|
| T*Micro-small[5] | 0.108*** | 0.082** | 1.194*** | 0.935*** |
| | [0.027] | [0.032] | [0.297] | [0.345] |
| T*Medium-big[6] | 0.028 | 0.019 | 0.349 | 0.315 |
| | [0.038] | [0.039] | [0.575] | [0.590] |
| Observations | 6,950 | 6,950 | 6,392 | 6,392 |
| Mean | 0.311 | 0.296 | 4.179 | 4.002 |
| | [0.463] | [0.457] | [6.339] | [6.257] |
| Firms | 3475 | 3475 | 3196 | 3196 |
| Control | 3121 | 3121 | 2868 | 2868 |
| Treated | 354 | 354 | 328 | 328 |

Source: Author's estimates based on WBES, LACES and PROTEqIN using IPW Diff-in-Diff.
Notes: (1) Export: Probability to start exporting. (2) Ln Exports: IHST Volume of total exports.(3) Probit: Probit IPW. (4) RF: Random Forest IPW. (5)Micro-small: Firms with $< 51$ Employees & $< U\$S2.7M$ in sales. (6)Medium-Big: Firms with $> 50$ Employees or $> U\$S2.7M$ in sales. (7) Time varying controls for Foreign ownership, Manager Experience and own Website. (8) Firm-level fixed effects and Country and Sector specific trends included. (9) Clustered standard errors at country-sector-year level in brackets. *** p<0.01, ** p<0.05, * p<0.1

### 5.1.2 Effect on Direct and Indirect Exports

Total exports can be decomposed in direct and indirect exports[17]. Columns 1 and 2 of Table 7 indicate that, on average, no significant effect was found over the probability of start exporting directly. However, the effect is positive and significant for the case of indirect exports as displayed in columns 3 and 4. Columns 5 to 8 reflect a similar pattern but this time for to the volume of exports, i.e. the increase in sales volume was significant only for indirect exports. However, when we decompose the effect by firm size, as can be seen in Table 8, effects are significant only for micro and small firms and specially for indirect exports[18].

Table 7: Effect of internationally-recognized quality certification on Direct and Indirect Exports

| | (1) Dir Exp[1] Probit[5] | (2) Dir Exp RF | (3) Ind Exp[2] Probit | (4) Ind Exp RF[6] | (5) Ln D Exp[3] Probit | (6) Ln D. Exp RF | (7) Ln I. Exp[4] Probit | (8) Ln I. Exp RF |
|---|---|---|---|---|---|---|---|---|
| Treated[7,8,9] | 0.028 | 0.001 | 0.047** | 0.043* | 0.380 | 0.107 | 0.528* | 0.504* |
| | [0.024] | [0.031] | [0.021] | [0.022] | [0.325] | [0.377] | [0.283] | [0.298] |
| Observations | 7,054 | 7,054 | 6,950 | 6,950 | 6,494 | 6,494 | 6,392 | 6,392 |
| Mean | 0.249 | 0.233 | 0.0930 | 0.0950 | 3.471 | 3.221 | 1.091 | 1.155 |
| | [0.433] | [0.423] | [0.290] | [0.293] | [6.027] | [5.868] | [3.594] | [3.684] |
| Firms | 3527 | 3527 | 3475 | 3475 | 3247 | 3247 | 3196 | 3196 |
| Control | 3170 | 3170 | 3121 | 3121 | 2916 | 2916 | 2868 | 2868 |
| Treated | 357 | 357 | 354 | 354 | 331 | 331 | 328 | 328 |

Source: Author's estimates based on WBES, LACES and PROTEqIN using IPW Diff-in-Diff.
Notes: (1) Dir Exp: Probability to start exporting directly. (2) Ind Exp: Probability to start exporting indirectly. (3) Ln D Exp: IHST Volume of direct exports. (4) Ln I Exp: IHST Volume of indirect exports. (5) Probit: Probit IPW. (6) RF: Random Forest IPW. (7) Time varying controls for Foreign ownership, Manager Experience and own Website. (8) Firm-level fixed effects and Country and Sector specific trends included. (9) Clustered standard errors at country-sector-year level in brackets. *** p<0.01, ** p<0.05, * p<0.1

[17] According to the WBES definition, direct exports are sales of goods where the intermediate recipient is outside the borders of the country, and indirect exports are sales of goods or services sold to a trader or third party who then exports the product without modifications.

[18] We also find positive effects of QC over direct exports of micro-small firms, but only for one of our identification strategies (Probit IPW).

Table 8: Effect of internationally-recognized quality certification on Direct and Indirect Exports (By Firm Size)

| | (1) Dir Exp[1] Probit[5] | (2) Dir Exp RF | (3) Ind Exp[2] Probit | (4) Ind Exp RF[6] | (5) Ln D Exp[3] Probit | (6) Ln D. Exp RF | (7) Ln I. Exp[4] Probit | (8) Ln I. Exp RF |
|---|---|---|---|---|---|---|---|---|
| T*Micro-small[7] | 0.053* | 0.018 | 0.053** | 0.050** | 0.734** | 0.325 | 0.502* | 0.541** |
| | [0.029] | [0.039] | [0.024] | [0.025] | [0.335] | [0.426] | [0.264] | [0.275] |
| T*Medium-big[8] | -0.010 | -0.025 | 0.039 | 0.033 | -0.184 | -0.241 | 0.571 | 0.446 |
| | [0.039] | [0.039] | [0.039] | [0.039] | [0.597] | [0.599] | [0.598] | [0.602] |
| Observations | 7,054 | 7,054 | 6,950 | 6,950 | 6,494 | 6,494 | 6,392 | 6,392 |
| Mean | 0.249 | 0.233 | 0.0930 | 0.0950 | 3.471 | 3.221 | 1.091 | 1.155 |
| | [0.433] | [0.423] | [0.290] | [0.293] | [6.027] | [5.868] | [3.594] | [3.684] |
| Firms | 3527 | 3527 | 3475 | 3475 | 3247 | 3247 | 3196 | 3196 |
| Control | 3170 | 3170 | 3121 | 3121 | 2916 | 2916 | 2868 | 2868 |
| Treated | 357 | 357 | 354 | 354 | 331 | 331 | 328 | 328 |

Source: Author's estimates based on WBES and PROTEqIN using IPW Diff-in-Diff.
Notes: (1) Dir Exp: Probability to start exporting directly. (2) Ind Exp: Probability to start exporting indirectly. (3) Ln D Exp: IHST Volume of direct exports. (4) Ln I Exp: IHST Volume of indirect exports. (5) Probit: Probit IPW. (6) RF: Random Forest IPW. (7)Micro-small: Firms with $< 51$ Employees & $< U\$S2.7M$ in sales. (8)Medium-Big: Firms with $> 50$ Employees or $> U\$S2.7M$ in sales. (9) Time varying controls for Foreign ownership, Manager Experience and own Website. (10) Firm-level fixed effects and Country and Sector specific trends included. (11) Clustered standard errors at country-sector-year level in brackets. *** p<0.01, ** p<0.05, * p<0.1

In summary, quality certification is found to increase both the extensive and intensive margins of trade. The increase in the amount exported might have been achieved either by exporting higher amounts to the same destinations or by entering new markets or introducing new products. For firms already exporting, entering new markets would be an argument in favor of certifications as an instrument to remove informational barriers that prevented them from demonstrating the quality of their products and process. This is the mechanism proposed by Volpe Martincus *et al.* (2010). Unfortunately, our dataset doesn't have information about export destinations or products. However, thanks to the decomposition between indirect and direct exports, we can propose an alternative mechanism to explain increases in intensive and extensive margins.

Our findings indicate that quality certifications, in average, don't affect extensive

margins of direct exports, but allows firms' introduction into the indirect exports market. Also, only indirect exports volume is increased due to certification adoption.

This evidence is consistent with the internationalization process proposed in the Intermediated Trade literature (Ahn *et al.*, 2011; Antras & Costinot, 2011; Bernard *et al.*, 2012; Akerman, 2018). Obtaining a quality certification would promote indirect internationalization of local firms by reducing transactions costs of informational barriers among wholesalers operating in local markets. However, this signaling effect coming from quality certification may not be enough to increase direct exports. As Bai *et al.* (2017) show, the sunk and fixed costs of exporting directly are much higher than the costs of exporting indirectly affecting the capacity of firms of contacting customers abroad, identifying business opportunities in foreign markets, and learning about distribution channels for their products and bureaucratic procedures (Leonidou, 2004).

Finally, thanks to the firm-size decomposition, we can confirm that the impact of QC on exports is totally driven by micro-small firms, while medium-big firms's exports are not affected by certification. This evidence is consistent with signaling effects operating strongly over micro-small firms, for which informational barriers are more important, promoting mostly indirect exports.

## 5.2 Effect on Local Sales and Finance restriction

Firms that seek to obtain benefits by signaling good business practices and quality control standards to their customers and providers in the domestic market should have an increase in their local sales[19]. Also, it is expected that firms that achieve a quality certification could manage to improve their financing due to an easing of credit restrictions. This might be due to the fact that certification is sometimes used as a criterion in credit institutions evaluation of a firm's creditworthiness, since it is associated with better future performance. Therefore, we estimate equation 1 using local sales and finance restriction[20] as outcome variables. Results for average effect are shown in Table 9 and results for the firm-size heterogeneous effects are presented in table 10.

[19] The WBES defines local (national) sales to good or services that are sold inside the borders of the country, excluding indirect exports or touristic services which are considered exports

[20] It is a dummy that takes the value of 1 when the firms perceive that finance restriction is a significant or severe barrier for growth and 0 otherwise

Columns 1 and 2 in Table 9 show that adopting a QC doesn't increase the amount of local sales significantly. However, as can be seen in columns 3 and 4, the effect over finance restriction is negative and significant for both methods indicating a reduction of around 7% on the firms' probability of finance restriction. Furthermore, as can be seen in Table 10, reduction in finance restriction is significant only for micro-small firms.

Table 9: Effect of internationally-recognized quality certification on Local Sales and Finance restriction

| | (1) Ln Local Sales[1] Probit[3] | (2) Ln Local Sales RF[4] | (3) Finance[2] Probit | (4) Finance RF |
|---|---|---|---|---|
| Treated[5,6,7] | 0.147 | 0.131 | -0.071** | -0.067** |
| | [0.158] | [0.157] | [0.034] | [0.034] |
| Observations | 6,392 | 6,392 | 6,946 | 6,946 |
| Mean | 13.93 | 13.93 | 0.264 | 0.271 |
| | [2.954] | [2.855] | [0.441] | [0.444] |
| Firms | 3196 | 3196 | 3473 | 3473 |
| Control | 2868 | 2868 | 3125 | 3125 |
| Treated | 328 | 328 | 348 | 348 |

Source: Author's estimates based on WBES, LACES and PROTEqIN using IPW Diff-in-Diff.
Notes: (1) Ln Local Sales: IHST Volume of domestic sales. (2) Finance: Probability of being finance restricted (3) Probit: Probit IPW. (4) RF: Random Forest IPW. (5) Time varying controls for Foreign ownership, Manager Experience and own Website. (6) Firm-level fixed effects and Country and Sector specific trends included. (7) Clustered standard errors at country-sector-year level in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 10: Effect of internationally-recognized quality certification on Local Sales and Finance restriction (by firmsize)

| | (1) Ln Local Sales[1] Probit[3] | (2) Ln Local Sales RF[4] | (3) Finance[2] Probit | (4) Finance RF |
|---|---|---|---|---|
| T*Micro-small[6] | 0.122 | 0.129 | -0.079* | -0.082* |
| | [0.155] | [0.150] | [0.041] | [0.042] |
| T*Medium-big[7] | 0.186 | 0.133 | -0.058 | -0.044 |
| | [0.314] | [0.315] | [0.056] | [0.054] |
| Observations | 6,392 | 6,392 | 6,946 | 6,946 |
| Mean | 13.93 | 13.93 | 0.264 | 0.271 |
| | [2.954] | [2.855] | [0.441] | [0.444] |
| Firms | 3196 | 3196 | 3473 | 3473 |
| Control | 2868 | 2868 | 3125 | 3125 |
| Treated | 328 | 328 | 348 | 348 |

Source: Author's estimates based on WBES and PROTEqIN using IPW Diff-in-Diff.
Notes: (1) Ln Local Sales: IHST Volume of domestic sales. (2) Finance: Probability of being finance restricted (3) Probit: Probit IPW. (4) RF: Random Forest IPW. (5) Time varying controls for Foreign ownership, Manager Experience and own Website. (6) Firm-level fixed effects and Country and Sector specific trends included. (7) Clustered standard errors at country-sector-year level in brackets. *** p<0.01, ** p<0.05, * p<0.1



In summary, adopting an internationally-recognized quality certification doesn't produce the same positive effects on local sales than those we find for exports. There are at least three possible reasons for this finding. First, local customers (specially in Latin American and the Caribbean) may pay little or no attention to the firm's business practices and quality controls. Second, since local customers have closer contact with the firm, they have alternative ways to judge quality for themselves without requiring a certification. For example, they could interact with other firm's customers or they could visit firm's factory. Third, local customers in LAC may impose less severe trade barriers regarding quality certification than international

ones[21]. All these reasons are related to each other and show the importance of quality certifications in solving problems of asymmetries in information.

Also, adopting a QC leads to a reduction in the likelihood that firms consider access to credit as a barrier to their growth, specially the micro-small ones. Improving access to credit could be an important source of growth for firms because it enables them to deploy long-term investments, for example, in projects to improve (or expand) productive infrastructure or increase R&D spending leading to product and process innovations (Brito & Mello, 1995; Schiavo & Musso, 2008). Moreover, this positive finding regarding access to credit can, at the same time, enhance the effects on exports due to the importance of pre- and post-export financing (Bellone *et al.*, 2010). In particular, better financial conditions of the firms allow to upgrade the production process to activities with higher value-added (Dai *et al.*, 2016).

## 5.3 Effects on Productivity

The effects analyzed so far have been mainly related to reduced informational barriers with certain agents external to the firm (local and international). Another hypothesis could be that firms adopting quality certification become more productive due to the implementation of internationally standardized process. Hence, we estimate equation 1 for labor productivity and TFP. Tables 11 and 12 present the results.



[21] For instance, Corbett (2008) indicates that diffusion of ISO 9001 adoption can be explained through supply chain relationships with European firms' as central nodes. Also, most of ISO certifications are concentrated in Europe and Asia. That means that, for LAC firms, QC may be more important for trade with European and Asian firms than for trading locally.

Table 11: Effect of internationally-recognized quality certification on productivity

| | (1) Labor Prod[1] Probit[3] | (2) Labor Prod RF[4] | (3) TFP[2] Probit | (4) TFP RF |
|---|---|---|---|---|
| Treated[5,6,7] | -0.002 | 0.029 | -0.091 | -0.001 |
| | [0.085] | [0.083] | [0.125] | [0.125] |
| Observations | 6,488 | 6,488 | 1,888 | 1,888 |
| Mean | 10.05 | 10.05 | 1.422 | 1.391 |
| | [1.687] | [1.623] | [0.775] | [0.774] |
| Firms | 3244 | 3244 | 944 | 944 |
| Control | 2913 | 2913 | 840 | 840 |
| Treated | 331 | 331 | 104 | 104 |

Source: Author's estimates based on WBES, LACES and PROTEqIN using IPW Diff-in-Diff.
Notes: (1) Labor Prod: Ln of Labor Productivity. (2) TFP: Ln of Total Factor Productivity (3) Probit: Probit IPW. (4) RF: Random Forest IPW. (5) Time varying controls for Foreign ownership, Manager Experience and own Website. (6) Firm-level fixed effects and Country and Sector specific trends included. (7) Clustered standard errors at country-sector-year level in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 12: Effect of internationally-recognized quality certification on productivity (by firmsize)

| | (1) Labor Prod[1] Probit[3] | (2) Labor Prod RF[4] | (3) TFP[2] Probit | (4) TFP RF |
|---|---|---|---|---|
| T*Micro-small[6] | 0.108 | 0.133 | -0.092 | -0.023 |
| | [0.096] | [0.094] | [0.151] | [0.137] |
| T*Medium-big[7] | -0.178 | -0.138 | -0.089 | 0.037 |
| | [0.145] | [0.142] | [0.210] | [0.231] |
| Observations | 6,488 | 6,488 | 1,888 | 1,888 |
| Mean | 10.05 | 10.05 | 1.422 | 1.391 |
| | [1.687] | [1.623] | [0.775] | [0.774] |
| Firms | 3244 | 3244 | 944 | 944 |
| Control | 2913 | 2913 | 840 | 840 |
| Treated | 331 | 331 | 104 | 104 |

Source: Author's estimates based on WBES, LACES and PROTEqIN using IPW Diff-in-Diff.
Notes: (1) Labor Prod: Ln of Labor Productivity. (2) TFP: Ln of Total Factor Productivity (3) Probit: Probit IPW. (4) RF: Random Forest IPW. (5) Time varying controls for Foreign ownership, Manager Experience and own Website. (6) Firm-level fixed effects and Country and Sector specific trends included. (7) Clustered standard errors at country-sector-year level in brackets. *** p<0.01, ** p<0.05, * p<0.1

We find no statistically significant effects of acquiring a quality certification on either labor productivity or TFP, neither heterogeneous effects among firm size. However, certain aspects of these estimates are worth highlighting. First, since questionnaire question on raw materials and capital has a lower response rate, the number of observations for TFP's estimates is a third of the total, which generate higher variance of the parameters and hampers identification of impacts.

Besides that, obtaining an internationally-recognized quality certification may not, in fact, lead to increased productivity. However, it does not imply that adopting

better managerial practices do not have an impact on the firm's productivity. It could happen that the companies that decide to certify had already previously implemented the required improvements and already comply (or were close to complying) what was required to certify. This argument reinforces the idea that the main benefit of certification is the signaling of desirable firm's characteristics for certain agents and the reduction of trade barriers, especially for exporting.

However, given the positive effect of certification on a firm's export potential, it may set in motion a learning-by-exporting process, in which the firm can improve its productivity, albeit indirectly, based on the knowledge acquired after starting to export, or through access to credit. Firms may decide to install better machinery, provide training for its employees, increase expenditure on R&D, and so forth. That is, it is expected that the increase in productivity is more an indirect consequence of the export behavior and access to credit due to certification adoption than a direct effect of this.

Therefore, the temporal dynamic of the impact need to be taken into account. In our database, the time gap between one period and another is only four years. However, certification can occur at any intermediate point, including immediately after responding to the first questionnaire or immediately before responding to the second. It is therefore possible that the effect on firm productivity is not registered because it requires a longer window of time to materialize. Since our time-lapse is a short-run period, our results are consistent with (Javorcik & Sawada, 2018) in which productivity effects are not seen until the third year of certification.



# 6 Falsification tests

For evaluating the robustness of our findings, we propose two alternative experiments imitating our identification strategy but using different firms falsely classified as treatment group. The purpose of these experiments is to try to falsify our previous findings. The impossibility of reproducing the estimated effects with these methodologies will be evidence favoring our conclusions[22].

Experiment A consists on creating a false treatment group conformed by those

[22] We present results only for Random Forest methodology and for previous significant effect. However, we checked that results can not be falsely reproduced for any method or outcome

firms who didn't have a Quality Certification in the first period, but in the follow up survey declared having a Quality Certification in process (not awarded yet). Results provided in Table 13 confirms that none of our significant previous findings can be reproduced using in-process certification as treatment indicator. We believe this is an almost ideal group for mimic treatment because those firms also self-selected into a certification process. Finding no significant effects provides further evidence in favor of the causal effect of effectively certifying by international quality standards. However, it can be argued that non-significant coefficients are due to the relatively small number of firms with quality certification in process. For this reason, we propose a second falsification test.

Experiment B consists on selecting into the false treatment group firms who didn't receive a quality certification, but are as similar as possible to firms who actually received the treatment. For that, we firstly matched 1-to-1 quality certified firms to false treatment group using Genetic Matching algorithm (Diamond & Sekhon, 2013) and later we repeat our identification strategy[23]. Table 14 confirms that no significant effects can be falsely reproduced using similar firms providing further support on the validity of our previous findings.

Table 13: Falsification test A. Effect of In-Process Quality Certification on Firm Performance

| | (1) Ln Loc. Sales RF | (2) Export RF | (3) Ind. Export RF | (4) Ln Exp. RF | (5) Ln. Ind. Exp RF | (6) Finance RF |
|---|---|---|---|---|---|---|
| In-Process | 0.118 | 0.007 | 0.044 | 0.334 | 0.532 | -0.034 |
| Quality Cert. | [0.223] | [0.049] | [0.046] | [0.716] | [0.639] | [0.051] |
| Observations | 5,666 | 6,166 | 6,166 | 5,666 | 5,666 | 6,174 |
| Mean | 14.31 | 0.284 | 0.098 | 3.815 | 1.240 | 0.243 |
| | [2.216] | [0.451] | [0.297] | [6.037] | [3.782] | [0.429] |
| Firms | 2833 | 3083 | 3083 | 2833 | 2833 | 3087 |
| Control | 2757 | 2996 | 2996 | 2757 | 2757 | 3002 |
| Treated | 76 | 87 | 87 | 76 | 76 | 85 |

Source: Author's estimates based on WBES, LACES and PROTEqIN using Random Forest IPW DID.
Time varying controls for Foreign ownership, Manager Experience and own Website.
Firm-level fixed effects and Country and Sector specific trends included.
Clustered standard errors at country-sector-year level in brackets. *** p<0.01, ** p<0.05, * p<0.1

[23] Aware of the recent findings of King & Nielsen (2019b) indicating the risks of matching over the propensity score, we used genetic matching proposed by Diamond & Sekhon (2013). The algorithm to iteratively reduce mahalanobis distance between covariates until no extra gains can be achieved

Table 14: Falsification test B. 1-to-1 Genetic Matching

| | (1) Ln Loc. Sales RF | (2) Export RF | (3) Ind. Export RF | (4) Ln Exp. RF | (5) Ln. Ind. Exp RF | (6) Finance RF |
|---|---|---|---|---|---|---|
| 1-to-1 Genetic | -0.058 | -0.003 | 0.004 | -0.153 | 0.093 | 0.001 |
| Match | [0.099] | [0.018] | [0.016] | [0.249] | [0.216] | [0.030] |
| Observations | 5,736 | 6,242 | 6,242 | 5,736 | 5,736 | 6,250 |
| Mean | 13.88 | 0.289 | 0.0970 | 3.849 | 1.188 | 0.271 |
| | [2.542] | [0.453] | [0.296] | [6.091] | [3.694] | [0.445] |
| Firms | 2868 | 3121 | 3121 | 2868 | 2868 | 3125 |
| Control | 2530 | 2759 | 2759 | 2530 | 2530 | 2764 |
| Treated | 338 | 362 | 362 | 338 | 338 | 361 |

Source: Author's estimates based on WBES and PROTEqIN using Random Forest IPW DID.
Time varying controls for Foreign ownership, Manager Experience and own Website.
Firm-level fixed effects and Country and Sector specific trends included.
Clustered standard errors at firm-level in brackets. *** p<0.01, ** p<0.05, * p<0.1

# 7 Conclusion

This study presents empirical evidence at the firm level for the LAC region for the determinants of adopting an internationally-recognized quality certification and their effects on firm performance using the WBES, LACES and PROTEqIN surveys from 27 countries. The results indicate that exporting firms, foreign firms, and firms with higher sales volume have the highest ex-ante probabilities of obtaining a quality certification.

We then find that obtaining a quality certification produce a positive effect by signaling desirable characteristics to firm's external agents for whom the relationship has more information asymmetries. In addition, we find that QC produces heterogeneous impacts according to the size of the company, being only significant for SMEs. Thus, firms that obtained this certification achieved to start exporting indirectly. Furthermore, firms already exporting increased their volume of indirect exports. Signaling effects seems to be less important to local costumers and we do not find significant effects on local sales. Firms also improve their credit situation, as they reported that access to financing was easier after certification. We do not find statistically significant effects of the certification on either of the measures of firm productivity rejecting Ullah *et al.* (2014) previous findings for LAC.

Our findings provide several useful considerations for productive development policymakers. First, the study provides information about the types of firms that are most likely to seek and achieve a quality certification. The fact that firms with more internationalized profile (i.e., exporters and foreign owned) are most likely to certify may be a signal of informational barriers regarding the benefits and requirements for quality certifications. This indicates that public intervention can play and important role eliminating this barrier by providing public information about international business opportunities for certified firms, and also offering training programs on quality process, reducing then informational costs for less experienced firms operating locally.

Regarding public policy design, policies or programs aimed to support certification for firms that require quality signaling to successfully entry (or expand) into foreign markets can be designed and implemented. For this purpose, those firms most hampered to information asymmetries and those less capable of facing certification's fixed costs must be identified. For instance, policies could be designed with focus on local firms that wish to incorporate to Global Value Chains with high differentiation. For the export process to be successful, these firms must demonstrate that they can produce efficiently and with high quality standards, reducing the risks of failures and delivery delays. This seems to be an important tool that facilitates integration between firms operating locally and international traders, fostering first-time indirect exports, and opens a path for the internationalization of local firms. Furthermore, small and finance restricted firms may be impeded for covering sunk costs of quality certification process despite the benefits they could perceive after that. Facilitating credit access or co-financing certifications could be an important policy tool for promoting exports.

Finally, the findings regarding productivity are not conclusive. The effect on firm performance may depend on the time periods during which the firm implements process improvements. In other words, it is possible that the immediate improvements are the ones observed in this paper and that, over a longer period, by starting to export and reducing the credit barrier, improvements in productivity can be achieved. However, the absense of short-run effects, while it is observed in other measures, reinforces the idea that certification is used to transmit information to other agents and not to improve managerial practices (that could previously implemented).

# A Appendix

Table 15: Data Description

| **Country** | **Survey** | **Years** | **Observations** | **% QC**[4] |
|---|---|---|---|---|
| Antigua and Barbuda | LACES[1], PROTEqIN[2] | 2011, 2014 | 224 | 6.69% |
| Argentina | WBES[3] | 2006,2010 | 918 | 30.28% |
| Barbados | LACES, PROTEqIN | 2011, 2014 | 184 | 25.54% |
| Belize | LACES, PROTEqIN | 2011, 2014 | 240 | 1.67% |
| Bolivia | WBES | 2006,2010 | 296 | 18.58 % |
| Brazil | WBES | 2003,2009 | 866 | 19.98% |
| Chile | WBES | 2006,2010 | 750 | 26.00% |
| Colombia | WBES | 2006,2010 | 584 | 17.64% |
| Dominica | LACES, PROTEqIN | 2011, 2014 | 234 | 3.85% |
| Ecuador | WBES | 2006,2010 | 310 | 22.58% |
| El Salvador | WBES | 2006,2010 | 220 | 17.73% |
| Grenada | LACES, PROTEqIN | 2011, 2014 | 206 | 37.86% |
| Guatemala | WBES | 2006,2010 | 252 | 15.87% |
| Guyana | LACES, PROTEqIN | 2011, 2014 | 118 | 38.98% |
| Jamaica | LACES, PROTEqIN | 2011, 2014 | 332 | 21.39% |
| Mexico | WBES | 2006,2010 | 358 | 29.05% |
| Nicaragua | WBES | 2006,2010 | 142 | 19.72% |
| Panama | WBES | 2006,2010 | 178 | 16.29% |
| Paraguay | WBES | 2006,2010 | 238 | 11.76% |
| Peru | WBES | 2006,2010 | 596 | 21.48% |
| St Kitts and Nevis | LACES, PROTEqIN | 2011, 2014 | 196 | 23.47% |
| St Lucia | LACES, PROTEqIN | 2011, 2014 | 237 | 2.94% |
| St Vincent and the G. | LACES, PROTEqIN | 2011, 2014 | 220 | 24.54% |
| Suriname | LACES, PROTEqIN | 2011, 2014 | 188 | 31.88% |
| The Bahamas | LACES, PROTEqIN | 2011, 2014 | 184 | 39.13% |
| Trinidad y Tobago | LACES, PROTEqIN | 2011, 2014 | 600 | 19.67% |
| Uruguay | WBES | 2006,2010 | 464 | 15.73% |
| Total | | | 9336 | 21.09% |

Notes: (1) LACES: Latin American Country Enterprise Survey. (2) PROTEQiN: Productivity, Technology, and Innovation in the Caribbean Survey. (3)WBES: World Bank Enterprise Survey (4)Share of observations with quality certification

Table 16: Probit Propensity Score

| | (1)<br>Prob. Treated |
|---|---|
| Log Total Sales | 0.083*** |
| | (0.030) |
| Log Employees | 0.035 |
| | (0.043) |
| Age | 0.005 |
| | (0.004) |
| $Age^2$ | -0.000 |
| | (0.000) |
| Direct Exporting Firm | 0.262 |
| | (0.160) |
| Log Exports | -0.008 |
| | (0.012) |
| Manager Experience | -0.007** |
| | (0.003) |
| Bank | 0.070 |
| | (0.065) |
| Website | 0.114 |
| | (0.073) |
| Foreign | 0.244** |
| | (0.103) |
| Observations | 3,660 |

Source: Author's estimates based on WBES, LACES and PROTEqIN.
Dummy by Country and Sector included
Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 17: Adjusted Baseline Covariate Mean Balance

| | | Unweighted | | Probit IPW | | R. Forest IPW | |
|---|---|---|---|---|---|---|---|
| | Treated | Control | Diff | Control | Diff | Control | Diff |
| Ln Employees | 3.590 | 3.175 | 0.415*** | 3.516 | 0.074 | 3.538 | 0.051 |
| | (1.317) | (1.136) | (0.071) | (1.208) | (0.075) | (1.285) | (0.076) |
| Ln Sales | 13.654 | 12.839 | 0.816*** | 13.494 | 0.160 | 13.539 | 0.115 |
| | (2.387) | (1.912) | (0.128) | (1.999) | (0.137) | (2.151) | (0.136) |
| Ln Local Sales | 13.864 | 13.251 | 0.613*** | 13.791 | 0.073 | 13.808 | 0.056 |
| | (3.121) | (2.351) | (0.166) | (2.678) | (0.182) | (2.810) | (0.180) |
| Exporter | 0.307 | 0.232 | 0.076*** | 0.291 | 0.017 | 0.286 | 0.022 |
| | (0.462) | (0.422) | (0.025) | (0.454) | (0.027) | (0.452) | (0.026) |
| Indirect Exporter | 0.080 | 0.086 | -0.006 | 0.079 | 0.001 | 0.088 | -0.008 |
| | (0.272) | (0.280) | (0.015) | (0.269) | (0.015) | (0.283) | (0.015) |
| Ln Exports | 4.113 | 2.889 | 1.224*** | 3.790 | 0.323 | 3.802 | 0.311 |
| | (6.352) | (5.360) | (0.341) | (6.060) | (0.371) | (6.148) | (0.365) |
| Ln Indirect Exp. | 0.946 | 1.018 | -0.073 | 0.982 | -0.036 | 1.100 | -0.154 |
| | (3.318) | (3.382) | (0.181) | (3.415) | (0.191) | (3.612) | (0.192) |
| Finance | 0.324 | 0.321 | 0.003 | 0.283 | 0.041 | 0.302 | 0.022 |
| | (0.469) | (0.467) | (0.026) | (0.451) | (0.027) | (0.459) | (0.026) |
| M. Experience | 18.382 | 19.080 | -0.698 | 18.451 | -0.069 | 18.775 | -0.393 |
| | (11.643) | (12.676) | (0.641) | (12.024) | (0.670) | (12.261) | (0.654) |
| Age | 24.406 | 22.297 | 2.109** | 23.873 | 0.533 | 24.032 | 0.374 |
| | (19.258) | (19.279) | (1.050) | (18.416) | (1.094) | (20.749) | (1.109) |
| Website | 0.479 | 0.366 | 0.113*** | 0.462 | 0.017 | 0.445 | 0.033 |
| | (0.500) | (0.482) | (0.027) | (0.499) | (0.029) | (0.497) | (0.028) |
| Foreign | 0.136 | 0.078 | 0.058*** | 0.136 | -0.000 | 0.116 | 0.021 |
| | (0.344) | (0.269) | (0.018) | (0.343) | (0.021) | (0.320) | (0.020) |
| Bank | 0.527 | 0.470 | 0.057** | 0.524 | 0.003 | 0.514 | 0.013 |
| | (0.500) | (0.499) | (0.027) | (0.500) | (0.029) | (0.500) | (0.028) |
| Ln Labor Prod. | 10.065 | 9.664 | 0.401*** | 9.978 | 0.086 | 10.001 | 0.064 |
| | (1.684) | (1.485) | (0.091) | (1.511) | (0.098) | (1.528) | (0.094) |
| TFP | 1.521 | 1.440 | 0.081 | 1.406 | 0.116 | 1.423 | 0.098 |
| | (0.921) | (0.869) | (0.083) | (0.912) | (0.088) | (0.953) | (0.088) |
| Multiv. F-test | | | 5.74*** | | 1.66* | | 1.45 |
| Weighted S. Size | 374 | 3,286 | 3,660 | 1,438 | 1,812 | 1,978 | 2,352 |

Source: Author's estimates based on WBES, LACES and PROTEqIN.
Note: Balanced groups by country and sector also achieved after weighting.
Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

# B Impact Evaluation Without control variables

Table 18: Effect of internationally-recognized quality certification on Total Exports

| | (1) Export[1] Probit[3] | (2) Export RF[4] | (3) Ln Exports[2] Probit | (4) Ln Exports RF |
|---|---|---|---|---|
| Treated[5,6,7] | 0.082*** | 0.064** | 0.959*** | 0.801** |
| | [0.024] | [0.027] | [0.305] | [0.341] |
| Observations | 7,208 | 7,208 | 6,616 | 6,616 |
| Mean | 0.316 | 0.300 | 4.268 | 4.080 |
| | [0.465] | [0.458] | [6.382] | [6.304] |
| Clusters | 668 | 668 | 646 | 646 |
| Control | 3234 | 3234 | 2968 | 2968 |
| Treated | 370 | 370 | 340 | 340 |

Source: Author's estimates based on WBES, LACES and PROTEqIN using IPW Diff-in-Diff.
Notes: (1) Export: Probability to start exporting. (2) Ln Exports: IHST Volume of total exports.(3) Probit: Probit IPW. (4) RF: Random Forest IPW. (5) Time varying controls not included. (6) Firm-level fixed effects and Country and Sector specific trends included. (7) Clustered standard errors at country-sector-year level in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 19: Effect of internationally-recognized quality certification on Direct and Indirect Exports

| | (1) Dir Exp[1] Probit[5] | (2) Dir Exp RF | (3) Ind Exp[2] Probit | (4) Ind Exp RF[6] | (5) Ln D Exp[3] Probit | (6) Ln D. Exp RF | (7) Ln I. Exp[4] Probit | (8) Ln I. Exp RF |
|---|---|---|---|---|---|---|---|---|
| Treated[7,8,9] | 0.031 | 0.004 | 0.047** | 0.043** | 0.377 | 0.125 | 0.568** | 0.545* |
| | [0.023] | [0.029] | [0.020] | [0.022] | [0.309] | [0.364] | [0.286] | [0.306] |
| Observations | 7,312 | 7,312 | 7,208 | 7,208 | 6,718 | 6,718 | 6,616 | 6,616 |
| Mean | 0.254 | 0.237 | 0.0960 | 0.0960 | 3.538 | 3.291 | 1.148 | 1.191 |
| | [0.435] | [0.425] | [0.295] | [0.295] | [6.066] | [5.920] | [3.683] | [3.743] |
| Clusters | 682 | 682 | 668 | 668 | 660 | 660 | 646 | 646 |
| Control | 3283 | 3283 | 3234 | 3234 | 3016 | 3016 | 2968 | 2968 |
| Treated | 373 | 373 | 370 | 370 | 343 | 343 | 340 | 340 |

Source: Author's estimates based on WBES, LACES and PROTEqIN using IPW Diff-in-Diff. Notes: (1) Dir Exp: Probability to start exporting directly. (2) Ind Exp: Probability to start exporting indirectly. (3) Ln D Exp: IHST Volume of direct exports. (4) Ln I Exp: IHST Volume of indirect exports. (5) Probit: Probit IPW. (6) RF: Random Forest IPW. (7) Time varying controls not included. (8) Firm-level fixed effects and Country and Sector specific trends included. (9) Clustered standard errors at country-sector-year level in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 20: Effect of internationally-recognized quality certification on Local Sales and Finance restriction

| | (1) Ln Local Sales[1] Probit[3] | (2) Ln Local Sales RF[4] | (3) Finance[2] Probit | (4) Finance RF |
|---|---|---|---|---|
| Treated[5,6,7] | 0.175 | 0.135 | -0.075** | -0.074** |
| | [0.150] | [0.155] | [0.034] | [0.035] |
| Observations | 6,616 | 6,616 | 7,194 | 7,194 |
| Mean | 13.94 | 13.90 | 0.270 | 0.278 |
| | [2.967] | [2.916] | [0.444] | [0.448] |
| Clusters | 646 | 646 | 674 | 674 |
| Control | 2968 | 2968 | 3232 | 3232 |
| Treated | 340 | 340 | 365 | 365 |

Source: Author's estimates based on WBES, LACES and PROTEqIN using IPW Diff-in-Diff.
Notes: (1) Ln Local Sales: IHST Volume of domestic sales. (2) Finance: Probability of being finance restricted (3) Probit: Probit IPW. (4) RF: Random Forest IPW. (5) Time varying controls for Foreign ownership, Manager Experience and own Website. (6) Firm-level fixed effects and Country and Sector specific trends included. (7) Clustered standard errors at country-sector-year level in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 21: Effect of internationally-recognized quality certification on productivity

| | (1) Labor Prod[1] Probit[3] | (2) Labor Prod RF[4] | (3) TFP[2] Probit | (4) TFP RF |
|---|---|---|---|---|
| Treated[5,6,7] | 0.026 | 0.056 | -0.105 | -0.003 |
| | [0.084] | [0.077] | [0.128] | [0.133] |
| Observations | 6,710 | 6,710 | 1,898 | 1,898 |
| Mean | 10.06 | 10.05 | 1.424 | 1.396 |
| | [1.686] | [1.623] | [0.781] | [0.791] |
| Clusters | 660 | 660 | 308 | 308 |
| Control | 3012 | 3012 | 845 | 845 |
| Treated | 343 | 343 | 104 | 104 |

Source: Author's estimates based on WBES, LACES and PROTEqIN using IPW Diff-in-Diff.
Notes: (1) Labor Prod: Ln of Labor Productivity. (2) TFP: Ln of Total Factor Productivity (3) Probit: Probit IPW. (4) RF: Random Forest IPW. (5) Time varying controls for Foreign ownership, Manager Experience and own Website. (6) Firm-level fixed effects and Country and Sector specific trends included. (7) Clustered standard errors at country-sector-year level in brackets. *** p<0.01, ** p<0.05, * p<0.1

# C Impact Evaluation without IPW

Table 22: Effect of internationally-recognized quality certification on Total Exports

| | (1) Export[1] | (2) Ln Exports[2] |
|---|---|---|
| Treated[3,4,5] | 0.060*** | 0.703** |
| | [0.023] | [0.311] |
| Observations | 6,950 | 6,392 |
| Mean | 0.244 | 3.132 |
| | [0.429] | [5.575] |
| Clusters | 666 | 644 |
| Control | 3121 | 2868 |
| Treated | 354 | 328 |

Source: Author's estimates based on WBES, LACES and PROTEqIN using Diff-in-Diff.
Notes: (1) Export: Probability to start exporting (2) Ln Exports: IHST Volume of total exports (3) Time varying controls for Foreign ownership, Manager Experience and own Website. (4) Firm-level fixed effects and Country and Sector specific trends included. (5) Clustered standard errors at country-sector-year level in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 23: Effect of internationally-recognized quality certification on Direct and Indirect Exports

| | (1) Dir Exp[1] | (2) Ind Exp[2] | (3) Ln D. Exp[3] | (4) Ln I. Exp[4] |
|---|---|---|---|---|
| Treated[5,6,7] | 0.012 | 0.044** | 0.197 | 0.509* |
| | [0.023] | [0.020] | [0.304] | [0.266] |
| Observations | 7,054 | 6,950 | 6,494 | 6,392 |
| Mean | 0.183 | 0.0910 | 2.395 | 1.071 |
| | [0.387] | [0.287] | [5.076] | [3.471] |
| Clusters | 680 | 666 | 658 | 644 |
| Control | 3170 | 3121 | 2916 | 2868 |
| Treated | 357 | 354 | 331 | 328 |

Source: Author's estimates based on WBES, LACES and PROTEqIN using Diff-in-Diff.
Notes: (1) Dir Exp: Probability to start exporting directly. (2) Ind Exp: Probability to start exporting indirectly. (3) Ln D Exp: IHST Volume of direct exports. (4) Ln I Exp: IHST Volume of indirect exports. (5) Probit: Probit IPW. (6) RF: Random Forest IPW. (7) Time varying controls not included. (8) Firm-level fixed effects and Country and Sector specific trends included. (9) Clustered standard errors at country-sector-year level in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 24: Effect of internationally-recognized quality certification on Local Sales and Finance restriction

| | (1) Ln Local Sales[1] | (2) Finance[2] |
|---|---|---|
| Treated[3,4,5] | 0.101 | -0.068** |
| | [0.151] | [0.032] |
| Observations | 6,392 | 6,946 |
| Mean | 13.44 | 0.284 |
| | [2.467] | [0.451] |
| Clusters | 644 | 672 |
| Control | 2868 | 3125 |
| Treated | 328 | 348 |

Source: Author's estimates based on WBES, LACES and PROTEqIN using Diff-in-Diff.
Notes: (1) Ln Local Sales: IHST Volume of domestic sales (2) Finance: Probablity of being finance restricted (3) Time varying controls for Foreign ownership, Manager Experience and own Website. (4) Firm-level fixed effects and Country and Sector specific trends included. (5) Clustered standard errors at country-sector-year level in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 25: Effect of internationally-recognized quality certification on Productivity

| | (1) Labor Prod[1] | (2) TFP[2] |
|---|---|---|
| Treated[3,4,5] | -0.030 | -0.050 |
| | [0.084] | [0.111] |
| Observations | 6,488 | 1,888 |
| Mean | 9.793 | 1.403 |
| | [1.568] | [0.695] |
| Clusters | 658 | 308 |
| Control | 2913 | 840 |
| Treated | 331 | 104 |

Source: Author's estimates based on WBES, LACES and PROTEqIN using Diff-in-Diff.
Notes: (1) Labor Prod: Ln of Labor Productivity (2) TFP: Ln of Total Factor Productivity (3) Time varying controls for Foreign ownership, Manager Experience and own Website. (4) Firm-level fixed effects and Country and Sector specific trends included. (5) Clustered standard errors at country-sector-year level in brackets. *** p<0.01, ** p<0.05, * p<0.1

# D Impact of Quality Certifications on Labor

Table 26: Effect of internationally-recognized quality certification on Labor

| | (1) Ln Labor[1] Probit[3] | (2) Ln Labor RF[4] |
|---|---|---|
| Treated[5,6,7] | 0.102** | 0.100* |
| | [0.050] | [0.051] |
| Observations | 7,040 | 7,040 |
| Mean | 3.602 | 3.583 |
| | [1.331] | [1.344] |
| Clusters | 680 | 680 |
| Control | 3164 | 3164 |
| Treated | 356 | 356 |

Source: Author's estimates based on WBES, LACES and PROTEqIN using IPW Diff-in-Diff.
Notes: (1) Ln Labor: Log number of Employees (2) Probit: Probit IPW. (3) RF: Random Forest IPW. (4) Time varying controls for Foreign ownership, Manager Experience and own Website. (5) Firm-level fixed effects and Country and Sector specific trends included. (6) Clustered standard errors at country-sector-year level in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 27: Effect of internationally-recognized quality certification on Labor (by firm-size)

| | (1) Ln Labor[1] Probit[3] | (2) Ln Labor RF[4] |
|---|---|---|
| T*Micro-small[6] | 0.144** | 0.127** |
| | [0.063] | [0.061] |
| T*Medium-big[7] | 0.038 | 0.057 |
| | [0.072] | [0.077] |
| Observations | 7,040 | 7,040 |
| Mean | 3.602 | 3.583 |
| | [1.331] | [1.344] |
| Clusters | 680 | 680 |
| Control | 3164 | 3164 |
| Treated | 356 | 356 |

Source: Author's estimates based on WBES, LACES and PROTEqIN using IPW Diff-in-Diff.
Notes: (1) Ln Labor: Log number of Employees (2) Probit: Probit IPW. (3) RF: Random Forest IPW. (4) Time varying controls for Foreign ownership, Manager Experience and own Website. (5) Firm-level fixed effects and Country and Sector specific trends included. (6) Clustered standard errors at country-sector-year level in brackets. *** p<0.01, ** p<0.05, * p<0.1

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