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Evaluación de impacto de un fondo de financiamiento para la innovación en pymes

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Abstract

Purpose – The purpose of this paper is to estimate the impact of one productive development program (PROPYME) in a developing nation like Costa Rica. This program seeks to increase the capacity of small and medium-sized firms (SMEs) to innovate.
Design/methodology/approach – Impacts have been estimated assuming that beneficiary firms are trying to maximize their profits and that PROPYME aims to increase these firms productivity. The impacts were measured in terms of three result variables real average wages employment demand and the probability of exporting. A combination of fixed effects and propensity score matching techniques was used in estimations to correct for any selection bias. The authors worked with panel data companies treated and untreated for the period 2001-2011.
Findings – PROPYME's beneficiaries performed better than other firms in terms of labor demand and their probability of exporting. In addition, the dose and the duration of the effects of the treatment (timing effects) are important.
Originality/value – The authors study the impact in ways that go beyond the average treatment effects on the treated (ATT) usually estimated in the existing literature. Specifically, the research focusses on the identification of the timing or dynamic effects (i.e. how long should we wait to see results?) and treatment intensity (dosage effects).
Keywords Impact evaluation, Innovation, Financing, Probability of exporting, Labour demand, R&D, SMEs, Costa Rica
Paper type Research paper

Resumen

Propósito – Se estima el impacto de un programa de desarrollo productivo (Propyme) en un país en vías de desarrollo como Costa Rica. El Propyme busca incrementar la capacidad innovadora de las pequeñas y medidas empresas (pymes) costarricenses.
Diseño/metodológico – el impacto se ha estimado y evaluado asumiendo que las pymes beneficiaras buscan maximizar sus beneficios y que Propyme se enfoca en incrementar la productividad de esas empresas. El impacto se valoró en función de tres variables: salarios reales medios, empleo demandado

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y la probabilidad de exportar. Se utilizó una combinación de técnicas de efectos fijos y emparejamiento en las estimaciones con el fin de prevenir sesgos de selección. Se trabajó con un panel de datos, incluyendo empresas tratadas (beneficiarias de Propyme) así como no tratadas para el periodo 2001-2011.

Hallazgos – los beneficiarios de Propyme tuvieron mejor desempeño que las restantes empresas en términos de empleo demandado y su posibilidad de exportar. Adicionalmente los efectos dinámicos (dosis y duración) de los tratamientos son importantes.

Originalidad y valor – este artículo evalúa el impacto de una forma que va más allá de lo usual en la literatura por medio de los efectos promedios de los tratamientos sobre los beneficiarios. Esto por cuanto se enfoca en efectos dinámicos como la duración así como la intensidad.

Palabras clave evaluación de impacto, innovación, financiamiento, probabilidad de exportar, empleo demandado, I+D, Pymes, Costa Rica

Tipo de papel Trabajo de investigación

Introduction

There is consensus among practitioners, policy makers and academics that innovation is vital to improve the productivity and performance of enterprises and nations. Besides, small and medium enterprises (SMEs) play a fundamental role in countries' economies (ECLAC-OECD, 2012). Thus fostering innovation in the SMEs is clearly a desirable goal.

Many countries have been interested in undertaking policies that promote investments in research and development (R&D) and other innovation-related activities by local firms due to the existence of market failures (Hobday *et al.*, 2012). In this regard, the literature shows different approaches. One is to design public policies to subsidize R&D activities through tax credits and the provision of non-reimbursable funds (Hausmann and Rodrik, 2002; Martin and Scott, 1998). Another approach has been to design policies that promote greater competition in the market, thereby generating higher levels of innovation (Baumol, 2002). Finally, a third approach has been to develop capital markets to encourage private investment in R&D (Martin and Scott, 1998).

However, this increase in policies aimed at fostering innovation through R&D activities, has not been matched, in the same magnitude, by actions to measure the impact (Dolfsma and Seo, 2013).

In a review of recent literature, López and Tan (2010) identified 19 rigorous impact evaluation studies, ten from high-income countries and nine from developing ones. Of these, only three were financing programs to promote investments in R&D, or to stimulate the development and introduction of new products and production processes in Latin American developing countries, as is the subject discussed in this paper (Chudnovsky *et al.*, 2006; De Negri *et al.*, 2006; Benavente *et al.*, 2007).

These studies suggest that SME programs are producing tangible impacts on the short and medium term intermediate outcomes that they are targeting (i.e. innovation intensity, technology adoption) but it is not clear whether these gains in intermediate outcomes translate into longer-term improvements in firm performance (sales, employment and labor productivity).

However, there is a persistent lack of measurements of the impact of government policies aimed at fostering R&D (Benavente *et al.*, 2012; Padilla-Pérez and Gaudin, 2014).

This paper aims to contribute to this topic by assessing the impact of PROPYME, which is a Government Fund to finance R&D activities in SMEs in Costa Rica. We study the impact in ways that go beyond the average treatment on treatment (ATT) usually estimated in the existing literature. Specifically, the research focusses on the identification of the timing or dynamic effects (i.e. how long should we wait to see results?) and treatment intensity (dosage effects).

In short, we attempt to answer the following questions:

(1) What are the impacts of PROPYME on firm performance?

(2) How long should we wait to see results from the intervention?

(3) Are additional doses of treatment necessary?

In sum, our paper provides evidence of positive impacts on longer-term improvements in firm performance.

The remainder of the paper is structured as follows. The second section presents a brief literature review. Third section provides basic information on PROPYME program. Fourth section presents the methodology employed to estimate the impact. Fifth section continues with a discussion of the findings, and sixth section presents the conclusion.

Literature review

Many countries have been interested in undertaking policies that promote investments in research and development (R&D) and other innovation-related activities by local firms due to the existence of market failures (Hobday *et al.*, 2012). When a firm invests in R&D and other innovation drivers, it generates knowledge that can be used by other firms. If a solid structure to enforce intellectual property rights is in place, monetary investment in R&D activities becomes the price of knowledge, given that those property rights allow the owner to exclude others from exploiting the new knowledge. However, even when the legal and institutional framework for intellectual property protection is in place, the innovator sometimes cannot fully own the benefits of her or his investment because of the presence of positive externalities due to technological or knowledge spillovers resulting from the innovation.

The basic idea of technological spillovers is that the effects of innovation by one firm tend to spill over into the rest of the economy, mainly to other firms that interact with the innovator (strategic partners, clients, suppliers, and even competitors) (Spencer, 2008).

This situation occurs when an innovative firm receives private marginal revenues which are less than its social marginal revenues; when the knowledge generated by the firm is spilling over into other firms, thus increasing the benefits to society as a whole beyond a simple increase in the innovating firm's profits. The only way for the innovating firm to obtain some part of the social marginal revenue would be to be paid for the innovation spilling over into other firms.

Another way of viewing knowledge spillovers is simply that the innovating firm could be facing a private marginal cost for knowledge production that is higher than the social marginal cost (i.e. the cost that the firm would face if R&D investments were also undertaken by other firms and thus the firm could also take advantage of spillovers from other innovators).

While the effects of externalities can be seen as differences between private and social revenues or as differences between private and social marginal costs, the outcome is the same: "the innovating firm is investing less in R&D than the socially optimum amount, which, combined with the convenience for other firms of acquiring new knowledge for free, collapses into a generalized underinvestment in R&D [in the country]" (Martin and Scott, 1998, p. 5). In order to correct this market failure, government intervention is justified. The question that arises, therefore, is what type of intervention (PDP) should be followed?

The classic theoretical argument is that the government should subsidize the private provision of knowledge either through tax credits on firms' investment in R&D or grants to create incentives for the private sector to undertake more innovation activities. Subsidies of this kind are permitted by the World Trade Organization's (WTO) rules, since they are part of the so-called "green box policies." According to Hausmann and Rodrik (2002), any government subsidy to increase the payoff for innovation should be reduced through time to impose discipline in the use of scarce resources.

In the case of either export-related activities or production for the domestic market, tax credits for R&D investments are an interesting policy tool that may unfortunately generate resistance among the governments of developing countries given the costs that they entail.

Moreover, Martin and Scott (1998) point out that the effectiveness of tax credits may be limited because they do not benefit startups, but rather apply only to R&D investments made by already established companies. This is a serious limitation since, as stated by Monge-González and Hewitt (2008) for the case of Costa Rica, new companies (startups) introduce new products to the market (innovations) most frequently.

There is evidence that more competition in a market should lead to greater levels of innovation and R&D investment (Baumol, 2002). Thus, policies that promote competition could provide incentives for private investment in R&D, since they help to overcome anti-competitive practices by incumbent firms and promote cooperative R&D practices. Trade policies are of particular interest to developing countries. Given that increased foreign competition and a larger variety of goods are made available to consumers by international trade, this creates additional incentives for firms to innovate more.

Another public policy to deal with the public nature of knowledge in the particular case of SMEs has to do with government support for capital market development in addition to other non-market instruments (i.e. grants and tax credits) (Martin and Scott, 1998).

These policies by themselves will not be as effective as they could be if they were accompanied by a policy of promoting the creation of clusters of innovative businesses in areas in which a country has clear comparative advantages. The effectiveness of any general policy for the promotion of innovation is weakened by geographic and economic distance between businesses, as well as the fact that some innovations occur in such a way as to minimize knowledge spillovers. Isolated policies (such as subsidizing R&D or research in universities) may therefore produce relatively weak and diffuse results (Rodríguez-Clare, 2004).

From the previous discussion, it is clear that the government has good arguments to promote R&D and innovation activities by SMEs because of market failures that impede optimal resource allocation. The correction of those failures is a necessary condition for improving the technological capabilities of SMEs.

PROPYME program

In Costa Rica, the idea of supporting investment in the R&D of SMEs originated almost two decades ago, with the Law on the Promotion of Scientific and Technological

Development (Law 7169) in 1990, created by the Ministry of Science and Technology of Costa Rica (MICIT). A decade later, in 2000, a new mechanism called Financing of Technological Management for Industrial Change, or the Grants Fund (FRC) was created. Its goal was to promote R&D in SMEs (companies with fewer than 100 employees) and enhance management capacities and competitiveness. Then the transformation of FRC into PROPYME was an important legal and institutional improvement. According to Law 8262, PROPYME resources come from Costa Rica's public budget, are allocated annually by the Incentives Commission at the MICIT, and are managed by the National Council for Scientific and Technological Research (CONICIT). Such a mechanism attempts to avoid resource allocation distortions caused by political influence, corruption, or moral hazard and discretionary management. The fund can be used to finance the following types of projects:

- technology development;
- innovation and patent creation;
- technology transfer;
- human capital development;
- technological services development; and
- a combination or complementary pool of projects.

The system operated until June 2012 in two stages on a yearly basis (with two application processes). First, a firm or group of firms submitted a project proposal to the Incentives Commission, which evaluated it according to standard criteria, including the type of scientific activity or technological area the firm is involved in, the potential impact on firm and sector productivity and competitiveness, the firm's scientific and technological capacity, the management capacity of the tender, and the probability that the firm's requirements may be effectively served by the proposed project. Second, qualifying projects competed for a joint venture with a certified research unit (RU)[1]. The RUs present their offers for projects that qualified in the first stage. The winning offers are selected according to quality, capacity, opportunity, and conditions offered by the RU as well as additional criteria approved by the Incentives Commission.

Once an RU is chosen to undertake a project, PROPYME may finance as much as 80 percent of its total cost with a non-reimbursable grant, while the SME has to finance the rest of project. The main idea is to induce entrepreneurship and invest more in R&D (learning what the SME is good at producing), given that the private profit of such investment falls below social returns (due to externalities). Thanks to recent efforts by MICIT, the operation of the system has been modified to make it much more flexible, allowing firms to participate from the beginning with an RU and allowing the presentation of proposals throughout the year.

An important reform of the PROPYME fund's operations was made in May 2011, but this reform did not enter into effect until June 2012, with the publication of the respective decree in the official Gazette. The first change was to open a window to receive applications from businesses throughout the year, instead of only once a year. The second change had to do with the possibility for a business to apply for PROPYME funds jointly with the RU of its choosing, from the beginning of the process. The third change implied reducing the time period in which CONICIT decides whether to approve an application from a business to a maximum of 30 natural days[2]. A fourth change was to make individuals eligible for PROPYME funds. A fifth reform allowed beneficiaries to participate in preparing the final draft of the agreement with MICIT for the use of PROPYME resources. Finally, a program was created whereby technological managers provide support to beneficiary businesses during their application for PROPYME resources.

The institutional setting is as follows. The MICIT is responsible for PROPYME policy design and implementation and is directly involved in monitoring and accountability. The Ministry of Economy, Industry and Commerce (MEIC) serves as a consultative body and elaborates the general framework. The CONICIT is responsible for monitoring and accountability issues. Interest groups from the private sector and research organizations (from both public universities and private centers) frequently contact PROPYME administrators to propose changes and improvements in regulatory mechanisms.

The results can be summarized as follows. Between 2003 and 2011, 170 project proposals were submitted to the MICIT; only 143 were finally approved. Of these 143 approved projects, only 114 were finally funded. These 114 innovation projects were carried out by 87 SMEs. The largest numbers of projects proposed were related to technological development, while the largest numbers of projects financed were related to human capital development. No firm requested funding for projects related to patents or technology transfers in this period. The total investment was US$1.7 million during that period, with an average of US$15,067 allocated to each firm (Table I). The average amount granted to technological development projects was US$27,930.

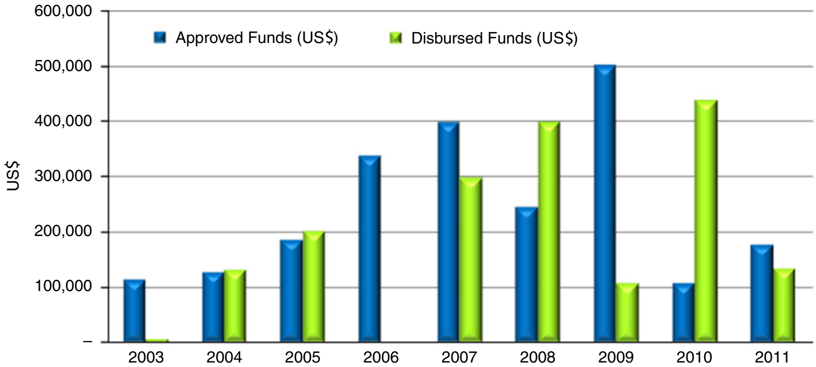
It is interesting to note that some firms decided not to participate once they had been informed of the research unit assigned to jointly implement the project with them. This situation explains the discrepancies in the amounts approved and executed in Figure 1 for the period analyzed. Additionally, even though a project may be approved in a given year, it may not be implemented in that same year.

Despite the clear limitations found by Monge-González *et al.* (2010), beneficiary firms indicate that PROPYME helped them become more competitive. According to these authors, most of the SMEs that received support from PROPYME were previously engaged in innovation activities and continued investing in technological improvements after receiving assistance from PROPYME. One of the main benefits

Type of project	Number of projects	Number of projects approved	Number of projects executed	Approved funds (US$)	Disbursed funds (US$)	Average per project (US$)	Maximum (US$)	Minimum (US$)
Technological development	66	42	32	1,094,863.50	893,773.22	27,930.41	170,131.43	1,129.93
Technological services	48	45	35	744,241.72	511,079.80	14,602.28	53,490.37	1,422.25
Technology transfer	–	–	–	–	–	–	–	
Patents	–	–	–	–	–	–	–	
Human capital	50	50	42	156,629.61	128,016.62	3,048.01	14,534.10	807.45
Hybrid projects	6	6	5	203,650.66	184,769.88	36,953.98	109,543.71	10,687.33
Total	170	143	114	2,199,385.49	1,717,639.52	15,067.01	170,131.43	807.45

Source: Databases from CONICIT, 2003-2011

Table I. Total amount of PROPYME funds according to type of project by state of the projects from 2003 to 2011



Source: Databases from CONICIT 2003-2011

Figure 1. PROPYME funds by state per year, 2003-2011

mentioned by beneficiaries was an improvement in the productivity of the firms, especially in terms of trained human resources and increased product sales. All of these results are expected to have an impact on the size of these firms (employment), salaries (due to higher productivity), and exports (increased market opportunities), which is the object of analysis in this paper.

Methodological approach

The challenge of carrying out an impact evaluation is to be able to compare the firm's performance after program intervention to what would have happened if the firm had not participated in the program (Storey, 2004). Since the hypothetical scenario (not participating in the program, having made it) cannot actually be seen, the challenge of impact evaluations consists in identifying a group of firms that are similar to the group receiving the treatment (program beneficiaries) in all aspects, except for their participation in the program. Thus, the difference between the average of the variable performance of treated firms and the average of the variable performance of companies in the control group would provide a good approximation of program impact.

We followed a quasi-experimental approach, which requires specific data on the program under consideration, including data on firms affected by the intervention or participating in the program and data on a control group of similar firms not affected and/or not participating. A panel of PROPYME treated and untreated companies between the years 2001 and 2011 was built for this purpose.

Since PROPYME beneficiaries were not randomly selected, the participation or selection of firms in the treatment and control groups should be based on observable and unobservable characteristics that can be controlled for (quasi-experimental design). The technique we used in carrying out the impact evaluations is a combination of regression methods and propensity score matching (PSM) that explicitly controls for differences in observable variables between groups and fixed-effects models. It also uses data from before and after the program (treated and control groups) to account for certain types of unobserved heterogeneity.

The PSM is a technique that aims to identify companies with similar characteristics to those treated by the program before the program is executed. To do this, we had to choose a group of observable variables that give a good characterization of the companies treated prior to treatment, and search similar values for the same variables in other companies (non-treated). The companies identified in this way made up the control group. Thus, any difference observed between the performance of the companies of the treatment group and the control group, after program execution, would be attributed to the participation of treated enterprises in the program under evaluation.

The correct selection of the control group is vital because any difference in performance between the control group and the treatment group, in terms of observed or unobserved attributes, affects the accuracy of the estimates of the program's net impact. For this reason, it is important to explain the selection strategy used to correct potential selection biases, and thus to be able to claim that the results obtained from the impact evaluation are actually attributable to the program intervention under analysis.

Strategy for identifying the control group

Since none of the firms in the panel data received PROPYME funds between 2001 and 2003 (because the program did not exist yet), these years are considered the base, or pre-treatment, years for the purposes of this analysis.

To estimate the impact on SME performance, we combined the PSM[3] method with the fixed-effects model. While PSM makes it possible to control for selection bias attributable to observable firm characteristics, the fixed-effects method makes it possible to control for non-observable attributes which are considered to be fixed over time (time-invariant firm characteristics) which may have an effect on a firm's decision to receive funds from PROPYME or on its performance over time[4].

To select the control group, it is necessary to carry out an analysis of the variables that characterize all of the firms before they become program beneficiaries (i.e. in 2002). Since beneficiary firms received funds from PROPYME at different times during the period studied, when estimating the PSM for the panel data it was necessary to calculate a dummy variable D, which takes the value 1 if the firm was a PROPYME beneficiary at least once during the 2004-2011 period, and 0 if it was never a beneficiary.

PSM estimates the probability of a firm's participation in PROPYME funds as a function of a set of observed variables. The first case consists of estimating the probability of participation as the matching criteria among beneficiary firms (treatment), and those that are not benefited (control). Given the large number of variables characterizing the firms, it is necessary to reduce their values for a firm to a scalar $p(x)$, defined below, in order to make matching possible. As pointed out by Bernal and Peña (2011), it is important not to either omit any variable or to over-specify the model. Careful attention must be paid to which variables to include.

The propensity score is defined as the conditional probability that a firm will become a PROPYME beneficiary, given the values of a set of observed variables X, which is expressed as:

$$p(x) = P\left(D = 1 \middle| X = x\right) = E\left(D \middle| X = x\right)$$

where X is a vector of individual characteristics or variables of the firm, and its environment.

$$D = \begin{cases} 1 \; if \;\; the\; firm\; is\; a\; beneficiary \\ 0, otherwise \end{cases}$$

Rosenbaum and Rubin (1983) show that given that whether a firm is a beneficiary or not is a result of a random selection process in the neighborhood defined by the multi-dimensional vector X, this selection is also random in the region defined by the scalar $p(x)$. Therefore, the average effect of the treatment PROPYME funds on beneficiary firms (ATT) may be specified through the equations:

$$ATT = E[Y_1 - Y_0] = E\left[E\left[Y_1 - Y_0 \middle| p(x)\right]\right]$$

And:

$$E\left[Y_1 \middle| p(x), D = 1\right] - E\left[Y_0 \middle| p(x), D = 0\right] = E\left[Y_1 - Y_0 \middle| p(x)\right]$$

where Y_i is the outcome variable on which the impact of the PROPYME program is being measured, and the sub-index i indicates the year of observation of the outcome variable.

The impact of PROPYME may then be estimated as the difference between the average of the outcome variable for the treatment group (beneficiaries) and that of the control group in the area of common support (where data display an overlap in the characteristics of beneficiaries and non-beneficiaries) defined by the PSM.

A problem with the estimation (ATT) is that it does not take into account the possibility of selection bias due to non-observed variables, complicated by the fact that the treatment does not occur, according to the panel data, within the same year for all firms, nor is it continuous once the business starts to be treated. We therefore estimated the programs' impact by using the PSM results to define the treatment and control groups in a way that meets the common support conditions and use the procedure for the estimation of the impact equations through a regression method using the fixed-effects approach.

Specification of the models and estimation procedure

To estimate the impact of PROPYME on SME performance, we applied a set of regression models to one panel data from 2004 to 2011, relating the outcome variable (wages, employment, or exports) to a set of covariates, including a dummy variable which measures whether or not the firm was a beneficiary of the program (D) sometime in that period. For the case of wages and employment, we derived the model specifications assuming that Costa Rican SMEs display profit-maximizing behavior.

For the cases of real wages and labor demand, the equations to be estimated (1 and 2) were obtained through a profit maximization procedure[5]. The estimation of Equations (1) and (2) was conducted using ordinary least square (OLS), using both fixed-effects and propensity score matching (PSM) plus fixed-effects approaches[6]. In the case of exports, a linear probability model was used to estimate the impact of the program on the probability that a firm exported sometime between 2004 and 2011 (Equation 3)[7]. In this last case, both fixed-effects and PSM plus fixed-effects approaches were used.

In short, the three equations we estimated were the following:

$$(w - p)_{it} = \beta_0 + \beta_1 (PREM * SE)_{it} + \beta_2 D_{it} + \beta_3 D_{it-1} + \beta_4 D_{it-2} + \beta_5 X_{it} + \varepsilon_{it} \tag{1}$$

$$l_{it} = \gamma_0 + \gamma_1 D_{it} + \gamma_2 D_{it-1} + \gamma_3 D_{it-2} + \gamma_4 X_{it} + \sigma_{it} \tag{2}$$

$$exp_{it} = \delta_0 + \delta_1 D_{it} + \delta_2 D_{it-1} + \delta_3 D_{it-2} + \delta_4 X_{it} + \rho_{it} \tag{3}$$

where (w-p) is the average real wage paid by the firm (in logs), $PREM \times SE$ is the salary premium received by skilled workers, l the number of workers hired by the firm (in logs), exp a dummy variable equal to one if the firm exported in year t and 0 otherwise, and X the covariates. Each error term in Equations (1)-(3) is a two-component term, with one component related to an unobserved specific effect of the firm which does not vary over time (productive sector, managerial capacity, etc.), but which may have an impact on the outcome variable, and another component which is purely stochastic.

We estimated another specification of Equation (3) that includes lag values of the dependent variable. This was done because a firm's exports in year t are explained by its export experience in year t-1, t-2 and t-3. Thus, a dynamic linear probability model is estimated. According to the standard in the literature, we used the fixed-effect approach in the estimation of this new specification.

In addition to estimating Equations (1)-(3), we explored the timing of the effects and whether dosage is really important, following Crespi *et al.* (2011). In doing so and for the case of timing of effects, we modified the above three equations, substituting another dummy called *D*_timing for the impact variable *D*. This new dummy takes the value of 1 for all the years since the first intervention and 0 otherwise. For the dosage effect, we substituted another variable called *D*_dosage for the impact variable *D*, which takes the value of 1 for all the years since the first year the firm was treated and until the year before the second treatment, equal to 2 since the second year the firm was treated and until the year before the third treatment, and so on, and 0 otherwise. In other words, we consider the case whereby a firm was a beneficiary in more than one year.

Data

We collected information on the beneficiaries, which we linked with social security and export data to obtain micro-data on final outcomes (total employment, average wages, and exports) as well as on industry sector, location, and legal status of the firm. As appropriate data, they came from various government sources (ministries, social security, and foreign trade). This allowed us to build the panel of both PROPYME treated and untreated companies between the years 2001-2011.

Results

Before showing the results of PROPYME impact evaluation, we present the results from the propensity score matching (PSM) technique used to identify the firms belonging to the control group, specifically to the common support.

Estimation of the propensity score and construction of the common support

Table II shows the variables that we include in the estimation of the propensity score for the sample firms as well as the results of the estimation. We estimated the probability that firms participated in the program between 2004 and 2011 using firm characteristics between 2001 and 2003, before any of the firms included in the sample participated in the program.

We use propensity scores estimated through the participation model presented in Table II to identify firms that did not participate in the program but that have the closest propensity score values to firms that did participate in the program. Variables in the participation model include: geographic location (provinces), since most of the firms are located in the central area of Costa Rica; legal status of the firm (that is, if the

Table II. Estimation of the probit function for propensity score matching, measured in the period 2001-2003

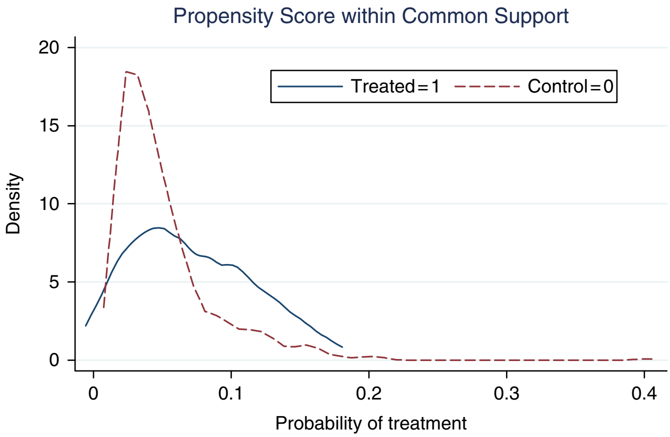
Variables	Coefficients
Firm is located in San José	−0.0903 (0.1755)
Firm has a legal status	0.5421 (0.4038)
Manufacturing	0.3117 (0.1817)*
Chemicals	−0.5148 (0.3093)*
Firm exported in the year 2001	0.4800 (0.2362)**
Labor growth b/w 2001 and 2003	0.7797 (0.3428)**
Number of employees in 2003 (logs)	−0.3488 (0.1942)*
Real salaries in 2003 (logs)	0.2823 (0.1386)**
Salaries growth b/w 2001 and 2003	−0.5016 (0.2466)**
Constant	−6.1060 (1.8541)***
Number of observations	698
Wald $\chi^2(9)$	21.04
Prob > χ^2	0.0125
Pseudo R^2	0.0658

Notes: *,**,***Coefficient is statistically significant at the 10, 5, 1 percent levels, respectively; no asterisk means the coefficient is not different from 0 with statistical significance
Source: Authors' calculations

firm is legally registered as a commercial legal entity); sector of economic activity, since most treated firms conduct specific activities; and firm characteristics, such as number of workers, average wage, and a dummy variable that indicates whether the firm exported in 2001 (i.e. prior exporting experience).

Note that all of the coefficients included in the equation are significant, except location and legal status. In addition, the model as a whole is also significant, and therefore appropriate for the estimation of the probability of a firm – whether in the treatment group or in the control group – participating in the PROPYME program. To achieve common support, it is necessary to eliminate the 20 percent of observations with the lowest density in the participation probability[8].

Figure 2 shows the distribution of the propensity scores after matching for firms. Ergo, it shows the PSM results for firms in the treatment and control groups previously selected within the common support.



Source: Authors' calculations

Figure 2. Density of treated and non-treated firms resulting from the PSM in the common support for PROPYME's impact evaluation

After identifying the firms in the control group – i.e., firms with similar values for the propensity score – it is necessary to verify that the characteristics of the control group are equal to the characteristics of those firms that participated in the program (see Rosenbaum and Rubin, 1983). We do this by analyzing *t* tests for equality of means in the treated and non-treated groups before and after matching (t tests are based on a regression of each variable on the treatment indicator).

Table III shows the balance in the observable variables before and after matching for the firms in the common support. After matching, it is not possible to reject the null hypothesis thatstates that – for all the variables simultaneously – differences in mean between firms in the program and in the control group are 0. Therefore, the treated and untreated groups – in the sample after the matching procedure – are statistically comparable based on the observable variables included in the participation model.

PROPYME's impact on real average wages

As indicated above, for a correct estimation of PROPYME's impact, both observable and non-observable variables whose behavior may affect the result variable must be controlled for, as well as businesses' participation in the program. Since the businesses that benefit from PROPYME are SMEs, the sample for the study – beneficiary and control group businesses – was limited to only businesses that hire up to 100 workers[9].

Results for real salaries (Equation 1) are presenzted in Table IV. The second column shows a positive and significant result for the treatment variable D_t (0.0939), which suggests that participation of businesses in PROPYME has a positive and significant impact on the real salaries they pay their employees. When the results of the first and second columns of Table IV are compared, it can be concluded that the wage premium for differences in employment categories (Prem×SE) is important in explaining the model, showing a positive and significant coefficient (0.0605).

Variable	Sample	Treated	Control	Difference	SE	*t*-stat.
Firm is located in San José	Unmatched	0.54839	0.58771	−0.03932	0.09062	−0.43
	Matched	0.56000	0.44000	0.12000	0.14329	0.84
Firm has a legal status	Unmatched	0.96774	0.88156	0.08618	0.05852	1.47
	Matched	0.96000	1.00000	−0.04000	0.04000	−1
Macnufacturing	Unmatched	0.64516	0.53523	0.10993	0.09161	1.2
	Matched	0.60000	0.40000	0.20000	0.14142	1.41
Chemicals	Unmatched	0.09677	0.13943	−0.04266	0.06335	−0.67
	Matched	0.12000	0.12000	0.00000	0.09381	0
Firm exported in year 2001	Unmatched	0.32258	0.13493	0.18765	0.06407	2.93
	Matched	0.20000	0.24000	−0.04000	0.11944	−0.33
Labor growth b/w 2001/2003	Unmatched	0.11153	0.04462	0.06691	0.07373	0.91
	Matched	0.07085	0.15280	−0.08195	0.10051	−0.82
No. Employees in 2003 (logs)	Unmatched	2.59054	2.28887	0.30167	0.22100	1.37
	Matched	2.50592	2.27133	0.23459	0.33340	0.7
Real salaries in 2003 (logs)	Unmatched	16.70874	16.26329	0.44545	0.28563	1.56
	Matched	16.63403	16.31679	0.31723	0.38450	0.83
Salaries growth b/w 2001/2003	Unmatched	0.25780	0.25768	0.00012	0.09679	0
	Matched	0.24447	0.33574	−0.09127	0.11565	−0.79

Source: Authors' calculations

Table III. Balance in observable variables before and after matching for PROPYME's impact evaluation

Table IV. Impact of PROPYME program on real average wages

Variables	(1) Fixed effects	(2) Fixed effects	(3) Fixed effects	(4) Fixed effects	(5) Fixed effects
D_t (Dummy equal to one if firm was treated in year t and 0 otherwise)	0.1669 (0.0432)***	0.0939 (0.0307)***	0.0832 (0.0295)***		
D_{t-1} (lagged treatment variable one year)			0.0298 (0.0264)		
D_{t-2} (lagged treatment variable two years)			0.0334 (0.0288)		
Prem×SE (Wage premium due to different labor categories)		0.0605 (0.0104)***	0.0605 (0.0104)***	0.0605 (0.0104)***	0.0605 (0.0104)***
D_timing_t (dummy variable equal to one for all the years since the first year the firm was treated, and 0 otherwise)				0.1069 (0.0335)***	
D_dosage_t (variable equal to one for all the years since the first year the firm w as treated and until the year before the second treatment happens, equal to tw o since the second year the firm w as treated and until the year before the third treatment happens, and so on, and 0 otherwise)					0.0421 (0.0136)***
Constant	13.7781 (0.0006)***	13.1688 (0.1051)***	13.1686 (0.1051)***	13.1680 (0.1050)***	13.1684 (0.1051)***
Observations	11,444	11,444	11,444	11,444	11,444
R^2	0.0018	0.3454	0.3455	0.3455	0.3453
Number of observations	2,048	2,048	2,048	2,048	2,048

Notes: Fixed effects and cluster-robust standard errors. *,**,***Coefficient is statistically significant at the 10, 5, 1 percent levels, respectively; no asterisk means the coefficient is not different from 0 with statistical significance
Source: Authors' calculations

On the other hand, it is interesting to note in column 3 that the impact of participation in PROPYME is experienced during the same year that the treatment is implemented, and not after a delay of one or two years. In addition, when *D_timing* is replaced by the treatment variable, and the dynamic effects (non-linear) of participation in PROPYME are analyzed, it appears that the longer a business receives the treatment, the greater the impact. In fact, the coefficient associated with D_*timing* is positive and significant (0.1069).

This result may be suggesting that firms that benefit from PROPYME later continue on an innovative path, which has a permanent impact on their performance. However, proving this is beyond the scope of the present study.

Finally, the result related to treatment dosage shown in column 5 (the coefficient associated with D_*dosage* is positive and significant, 0.0421) suggests that a firm that received benefits from PROPYME several times during the period analyzed (2004-2011) experienced greater real wages for its employees. This result could be due to the fact that beneficiary businesses may request support from PROPYME for several innovative activities, which may be considered complementary.

Although the results of the previous section suggest that participation of firms in PROPYME increased their real wages, it is pertinent to determine whether the comparison group used is appropriate. It may be concluded from the discussion in previous sections that common support, that is, the group of firms with similar probabilities of participating in the program, is much lower than the group of firms considered in the analysis when only the fixed-effects approach is used.

Therefore, models whose results are summarized in Table IV were estimated again controlling for fixed effects, but only for common support firms. These new estimations are considered to be more robust because firms that are not good "clones" of beneficiary firms are eliminated from the control group, according to the PSM. Table V shows the results of the impact of PROPYME on real salaries, using the fixed-effects approach and PSM, as well as testing for the parallel pre-treatment assumption.

In contrast to the results obtained in Table IV, those in Table V do not show any impact of PROPYME on real wages of beneficiary firms. In other words, none of the coefficients associated with the various specifications of the treatment variable (*D*, *D_timing* and *D_dosage*) were positive and significant. Moreover, since all of the coefficients associated with pre-treatment variables (*PD_r*; $r = 1, 2, 3$) in column 6 are not significant, the fixed-effects approach is valid as an estimation procedure in this case. Thus, it can be concluded that PROPYME does not have any impact on the average wages of beneficiary firms.

PROPYME's impact on labor demand

PROPYME's impact on labor demand (number of workers) according to Equation (2) is presented in Tables VI and VII. The results in the first of these tables refer to estimations using only the fixed-effects approach. From the first column of Table VI, it may be concluded that participation of businesses in PROPYME has a positive and significant impact on labor demand in beneficiary firms, given that the coefficient associated with the treatment variable –*D* – is positive and significant (0.2540).

In column 2, the impact of participation in PROPYME is experienced during the first year of treatment, as well as one and two years after the treatment (0.2188, 0.0954 and 0.1315). Moreover, when *D_timing* is replaced by the treatment variable, and the dynamic effects (non-linear) of participation in PROPYME are analyzed, the coefficient associated with D_*timing* is positive and significant (0.4037); i.e., the longer the firm receives treatment, the greater the impact on labor demand.

Table V. Impact of PROPYME program on real average wages

Variables	(1) PSM+fe	(2) PSM+fe	(3) PSM+fe	(4) PSM+fe	(5) PSM+fe	(6) Parallel pre-treatment trends test
D_t (dummy equal to one if firm was treated in year t and 0 otherwise)	0.0257 (0.0401)	0.0115 (0.0275)	0.0142 (0.0279)			0.0085 (0.0383)
D_{t-1} (lagged treatment variable one year)			−0.0083 (0.0164)			
D_{t-2} (lagged treatment variable two years)			0.0142 (0.0160)			
Prem×SE (wage premium due to different labor categories)		0.0618 (0.0067)***	0.0618 (0.0067)***	0.0618 (0.0067)***	0.0618 (0.0067)***	0.0618 (0.0067)***
D_timing_t (dummy variable equal to one since the first year the firm was treated, and 0 otherwise)				0.0340 (0.0305)		
D_dosage_t (variable equal to one for all the years since the first year the firm was treated and until the year before the second treatment happens, equal to two since the second year the firm was treated and until the year before the third treatment happens, and so on, and 0 otherwise)					0.0178 (0.0109)	
*PD*_1 (pre-treatment dummy equal to one for the first year before the firm was treated and 0 otherwise)						−0.0131 (0.0350)
*PD*_2 (pre-treatment dummy equal to one for the second year before the firm was treated and 0 otherwise)						−0.0239 (0.0450)
*PD*_3 (pre-treatment dummy equal to third for the first year before the firm was treated and 0 otherwise)						0.0279 (0.0391)
Constant	13.9370 (0.0004)****	13.2806 (0.0708)***	13.2806 (0.0708)***	13.2804 (0.0707)***	13.2805 (0.0707)***	13.2808 (0.0709)***
Observations	5,235	5,235	5,235	5,235	5,235	5,235
R^2	0.0001	0.3980	0.3980	0.3982	0.3983	0.3981
Number of observations	682	682	682	682	682	682

Notes: Propensity score matching, fixed effects and cluster-robust standard errors. *,**,***Coefficient is statistically significant at the 10, 5, 1 percent levels, respectively; no asterisk means the coefficient is not different from 0 with statistical significance
Source: Authors' calculations

Table VI. Impact of PROPYME program on labor demand

Variables	(1) Fixed effects	(2) Fixed effects	(3) Fixed effects	(4) Fixed effects
D_t (Dummy equal to one if firm was treated in year *t* and 0 otherwise)	0.2540 (0.0499)***	0.2188 (0.0456)***		
D_{t-1} (lagged treatment variable one year)		0.0954 (0.0462)**		
D_{t-2} (lagged treatment variable two years)		0.1315 (0.0542)**		
D_timing_t (dummy variable equal to one since the first year the firm was treated and so on, and 0 otherwise)			0.4037 (0.0764)***	
D_dosage_t (variable equal to one for all the years since the first year the firm was treated and until the year before the second treatment happens, equal to two since the second year the firm was treated and until the year before the third treatment happens, and so on, and 0 otherwise)				0.1452 (0.0331)***
Constant	2.0877 (0.0006)***	2.0862 (0.0010)***	2.0823 (0.0016)***	2.0850 (0.0014)***
Observations	11,444	11,444	11,444	11,444
R^2	0.0032	0.0044	0.0075	0.0051
Number of observations	2,048	2,048	2,048	2,048

Notes: Fixed effects and cluster-robust standard errors. *,**,***Coefficient is statistically significant at the 10, 5, 1 percent levels, respectively; no asterisk means the coefficient is not different from 0 with statistical significance
Source: Authors' calculations

Table VII.
Impact of PROPYME program on labor demand

Variables	(1) PSM+fe	(2) PSM+fe	(3) PSM+fe	(4) PSM+fe	(5) Parallel pre-treatment trends test
D_t (Dummy equal to one if firm was treated in year t and 0 otherwise)	0.1976 (0.0732)***	0.1878 (0.0689)***			0.1897 (0.0894)**
D_{t-1} (lagged treatment variable one year)		0.0291 (0.0429)			
D_{t-2} (lagged treatment variable two years)		0.0357 (0.0448)			
D_timing_t (dummy variable equal to one since the first year the firm was treated and so on, and 0 otherwise)			0.2339 (0.0717)***		
D_dosage_t (variable equal to one for all the years since the first year the firm was treated and until the year before the second treatment happens, equal to two since the second year the firm was treated and until the year before the third treatment happens, and so on, and 0 otherwise)				0.0638 (0.0314)**	
*PD*_1 (pre-treatment dummy equal to one for the first year before the firm was treated and 0 otherwise)					−0.0319 (0.0959)
*PD*_2 (pre-treatment dummy equal to one for the second year before the firm was treated and 0 otherwise)					0.0061 (0.0882)
*PD*_3 (pre-treatment dummy equal to third for the first year before the firm was treated and 0 otherwise)					−0.0432 (0.0662)
Constant	2.3810 (0.0008)***	2.3807 (0.0010)***	2.3787 (0.0014)***	2.3808 (0.0012)***	2.3813 (0.0016)***
Observations	5,235	5,235	5,235	5,235	5,235
R^2	0.0025	0.0026	0.0032	0.0012	0.0026
Number of observations	682	682	682	682	682

Notes: Propensity score matching, fixed effects and cluster-robust standard errors. *,**,***Coefficient is statistically significant at the 10, 5, 1 percent levels, respectively; no asterisk means the coefficient is not different from 0 with statistical significance
Source: Authors' calculations

In addition, the result of the treatment dosage (*D_dosage*) shown in column 4 suggests that the more times a firm has been treated with the PROPYME program during the period analyzed (2004-2011), the greater the labor demand. In other words, longer dosages of treatment seem to increase the labor demand of participating firms (the coefficient associated with *D_dosage* is positive and significant, 0.1452). This result could be due to the fact that beneficiary businesses may request support from PROPYME for several innovative activities that may be considered complementary.

Table VII presents the results of the impact of PROPYME assistance on labor demand using only common support firms and controlling for fixed effects. Once again, these estimations are considered to be stronger because firms which are not good "clones" of beneficiary firms according to PSM are eliminated from the control group.

The results in Table VII verify the existence of a positive and significant impact of PROPYME on labor demand in beneficiary firms. The coefficient associated with the treatment variable (*D*) is positive and significant (0.1976 in column 1 and 0.1878 in column 2). Importantly, the impact is only observed during the same year when the treatment is applied. Thus, the average impact of the program on treated firms is 0.19.

When the dynamic results of treatment (*D_timing*) are analyzed, a positive and significant coefficient is obtained (0.2339), leading us to conclude that the longer the time a firm is treated, the greater the impact on labor demand. The coefficient associated with the dosage (*D_dosage*) is positive and significant (0.0638), allowing us to claim that successive treatments have more of an impact on firms' labor demand than when they receive only one treatment.

Finally, since none of the coefficients associated with pre-treatment variables in column 5 are significant, the fixed-effects approach is valid as an estimation procedure in this case. Thus, we can conclude that the labor demand of treated firms is 19 percent higher than that of firms from the control group.

PROPYME's impact on the probability of exporting

The results of the impact of PROPYME on the probability of exporting obtained using equation (3) are shown in Tables VIII and IX. Table VIII shows the results using a linear probability model using only the fixed-effects approach. A consideration of the first column of this table shows that the coefficient associated with the treatment variable (*D*) is positive and significant (0.0876), which supports the conclusion that SME participation in the PROPYME program is important for these firms to increase their exporting probability. In fact, participation in PROPYME increases such a probability by almost nine percentage points on average for beneficiary firms with respect to those in the control group.

In addition, participation in PROPYME seems to have an impact on the exporting probability of beneficiary firms not only in the same year that they receive the treatment, but as long as two years after the treatment. Indeed, the coefficients associated with these effects are positive and significant (0.0944 and 0.0688, respectively), as shown in the second column of Table VIII.

Another interesting result of this analysis is that the longer a firm has been treated, the greater the impact on the probability of it exporting. The coefficient associated with the dynamic effect of the intervention (*D_timing*) shown in the third column of

Table VIII.
Impact of PROPYME program on the probability of exporting: linear probability model

Variables	(1) Fixed effects	(2) Fixed effects	(3) Fixed effects	(4) Fixed effects
D_t (Dummy equal to one if firm was treated in year t and 0 otherwise)	0.0876 (0.0252)***	0.0944 (0.0268)***		
D_{t-1} (lagged treatment variable one year)		–0.0263 (0.0193)		
D_{t-2} (lagged treatment variable two years)		0.0688 (0.0397)*		
D_timing_t (dummy variable equal to one since the first year the firm was treated and so on, and 0 otherwise)			0.0995 (0.0280)***	
D_dosage_t (variable equal to one for all the years since the first year the firm was treated and until the year before the second treatment happens, equal to two since the second year the firm was treated and until the year before the third treatment happens, and so on, and 0 otherwise)				0.0256 (0.0133)*
Constant	0.1226 (0.0003)***	0.1223 (0.0004)***	0.1216 (0.0006)***	0.1227 (0.0005)***
Observations	11,444	11,444	11,444	11,444
R^2	0.0027	0.0036	0.0032	0.0011
Number of observations	2,048	2,048	2,048	2,048

Notes: Fixed effects and cluster-robust standard errors. *,**,***Coefficient is statistically significant at the 10, 5, 1 percent levels, respectively; no asterisk means the coefficient is not different from 0 with statistical significance
Source: Authors' calculations

Table IX. Impact of PROPYME program on the Probability of Exporting: Linear Probability Model

Variables	(1) PSM+fe	(2) PSM+fe	(3) PSM+fe	(4) PSM+fe	(5) Parallel pre-treatment trends test
D_t (Dummy equal to one if firm was treated in year *t* and 0 otherwise)	0.0859 (0.0383)**	0.0960 (0.0423)**			0.0813 (0.0354)**
D_{t-1} (lagged treatment variable one year)		−0.0316 (0.0271)			
D_{t-2} (lagged treatment variable two years)		0.0501 (0.0838)			
D_*timing*$_t$ (dummy variable equal to one since the first year the firm was treated and so on, and 0 otherwise)			0.0714 (0.0385)*		
*D*_dosage$_t$ (variable equal to one for all the years since the first year the firm was treated and until the year before the second treatment happens, equal to two since the second year the firm was treated and until the year before the third treatment happens, and so on, and 0 otherwise)				0.0206 (0.0159)	
*PD*_1 (pre-treatment dummy equal to one for the first year before the firm was treated and 0 otherwise)					0.0364 (0.0421)
*PD*_2 (pre-treatment dummy equal to one for the second year before the firm was treated and 0 otherwise)					−0.0136 (0.0240)
*PD*_3 (pre-treatment dummy equal to third for the first year before the firm was treated and 0 otherwise)					−0.0866 (0.0699)
Constant	0.1532 (0.0004)***	0.1530 (0.0005)***	0.1528 (0.0007)***	0.1534 (0.0006)***	0.1534 (0.0004)***
Observations	5,235	5,235	5,235	5,235	5,235
R^2	0.0019	0.0023	0.0012	0.0005	0.0028
Number of observations	682	682	682	682	682

Notes: Propensity score matching, fixed effects and cluster-robust standard errors. *,**,*** Coefficient is statistically significant at the 10, 5, 1 percent levels, respectively; no asterisk means the coefficient is not different from 0 with statistical significance
Source: Authors' calculations

Table VIII is positive and significant (0.0995). It also seems that the more times a firm participates in the PROPYME program, the more its probability of exporting increases, which would indicate that innovation activities financed by this program seem to help beneficiary firms to improve the probability that they will succeed in placing their products in international markets. The coefficient associated with the dosage of the treatment variable (*D_dosage*) is positive and significant (0.0256).

When the propensity score matching and the fixed-effects approaches are used together to estimate the impact of PROPYME on exports of beneficiary firms, the results obtained for the treatment variable (*D*) and *D_timing* are similar to those obtained when the fixed-effects approach alone is used. However, these new results are stronger than the ones shown in Table VIII.

Thus, as shown in Table IX, the coefficients associated with these two treatment variables (*D* and *D_timing*) are positive and significant (0.0960 and 0.0714, respectively), confirming the importance of the participation of SMEs in the PROPYME program in improving their export probabilities. On the other hand, the coefficient associated with *D_dosage* is not significant. A similar result was also found for lagged treatment variables.

In short, it may be concluded that participation in PROPYME increases the exporting probability more than nine percentage points on average for beneficiary firms with respect to those in the control group.

Finally, as shown in the last column of Table IX, the parallel pre-treatment trends assumption is valid since all of the coefficients associated with pre-treatment variables are not significant. This last result means that the use of fixed-effects with PSM is a valid method of estimation of the impact of PROPYME on the exports probabilities of beneficiary firms.

Conclusions

This study has attempted to estimate the impact of one important productive development program in Costa Rica: PROPYME. Impacts have been estimated assuming that beneficiary firms are trying to maximize their profits and that PROPYME aims to increase these firms' productivity. The impact was estimated based on three performance variables: real average wages, labor demand, and the probability of exporting. The fixed-effects and propensity score matching approaches were used to control for selection biases and achieve a better comparison between beneficiary and control group firms in impact estimations. A test for parallel pre-treatment trends was undertaken as a robustness check for using a fixed-effects approach.

The PROPYME program was found to have positive and significant impacts on employment and the probability of exporting of beneficiary firms, but not on the real average wages of the employees of these firms. Among treated firms, labor demand was found to be about 19 percent higher than among untreated firms. The exporting probability of treated firms was found to be about 9.6 percentage points higher than that of untreated firms. These impacts were observed for up to two years after the firm participated for the first time in the program (in the case of exports). Similarly, the amount of time elapsed since the first treatment, as well as the number of times that an SME participated in the program, was found to have a positive impact on labor demand and on the probabilities of exporting of beneficiary firms.

These results are encouraging, considering that PROPYME during the period analyzed suffered from significant weaknesses. These included a lack of flexibility in selecting a partner with which to execute the project, the ability to enter into the program throughout the whole year, and a lack of adequate institutional coordination to provide beneficiary firms with other financial and non-financial services that would have contributed to better performance and greater chances for success. Recent efforts by Costa Rican authorities to improve the operations may contribute to maintaining and increasing the impact of PROPYME in the future.

Our paper contributes to the existing knowledge on the subject from various perspectives. It adds to the few rigorous impact evaluation studies for financing programs to promote investments in R&D, stimulate development and introduction of new products and production processes in developing countries.

We provide evidence of positive impacts on longer-term improvements in firm performance (employment) and intermediate outcomes (the probability of exporting). We coincide with Benavente *et al.* (2007) who found improvements in firm performance for a program for technology transfer and development and R&D support in Chile (National Productivity and Technology Development Fund, FONTEC). However, our results differ with De Negri *et al.* (2006) who found no impacts on employment for R&D subsidy programs and technology development in Brazil (National Technological Development Support Program, ADTEN) and with Tan (2010) who found no significant treatment effects for the use of credit and loans programs alone in Chile.

In sum, the findings suggest that policies aimed at overcoming the weaknesses of PROPYME are important to obtain higher employment opportunities and exports by Costa Rican SMEs.

Notes

1. The RU may belong to either a public or private university in Costa Rica or abroad, as well as a private research unit independent of any university (for instance, non-governmental organizations or the RU of a private firm).
2. For businesses that present their application without the support of a research unit, this time period is extended to 45 days.
3. Matching is a procedure by which firms that have characteristics similar to those in the treatment group (such as years of operation of the firm, economic sector, geographic location and number of employees) are randomly selected for the control group, according to variables that may have an effect on incentives to participate in the program and on firm performance, both before and after the intervention.
4. Matching or propensity score matching (PSM) is one of the most common methods used in sophisticated and robust impact evaluations, as seen in the most recent case studies for some Latin American countries (López and Tan, 2010). See also Bernal and Peña (2011, Chapter 6), for a detailed description of this procedure and a clear application to empirical cases.
5. See Appendixes 1 and 2 from Monge-González and Rodríguez-Álvarez (2013).
6. In the case of Equation (2) due to endogeneity problems with (w-p) as co-variable, what we estimated was a reduced form of the full equation derived from a profit maximization procedure.
7. We prefer this specification instead of a probit or logit model since we would like to use the fixed-effects method to control for non-observable attributes which are considered to be fixed over time and which may have an effect on a firm's decision to receive funds from PROPYME or CR Provee, or on its performance over time.

8. That is, firms in the treatment group which are above the maximum observed in the control group are eliminated, while those firms in the control group which are below the minimum observation of the treatment group are also eliminated.
9. According to the classification of the Costa Rican Ministry of Economy, Industry, and Commerce (MEIC), in which micro-businesses are those with five or fewer employees, small-sized businesses are those that have between 6 and 30 employees, and medium-sized businesses are those which have between 31 and 100 employees.

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