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The Cases of PROPYME and CR Provee

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Abstract[1]

This paper estimates the impact of two productive development programs (PDPs) in Costa Rica: PROPYME and CR Provee. The first seeks to increase the capacity of small and medium-sized firms (SMEs) to innovate, and the second aims to increase backward linkages between Costa Rican SMEs and multinational companies operating in the country. The impacts of each program 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 results show that both PROPYME and CR Provee have positive and significant impacts on SME performance. PROPYME's beneficiaries performed better than other firms in terms of labor demand and their probability of exporting, while firms treated by CR Provee showed higher average wages, labor demand, and chances of exporting than untreated firms. Firms treated simultaneously by both programs performed better in terms of average wages than those that were only treated by CR Provee. This result is of special interest to policymakers since it indicates the importance of bundling in the implementation of PDPs. The findings suggest that policies aimed at overcoming the weaknesses of these two programs are important for obtaining higher real wages, generating more employment, and increasing the probability of exporting by Costa Rican SMEs.

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1. Introduction

The traditional discussion on industrial policy, or productive development policies (PDPs), in developing countries has focused on whether, rather than how, the government should be involved in trying to correct market failures that impede the efficient allocation of productive resources, goods and services (Rodrik, 2007). Melo and Rodríguez-Clare (2006) define PDPs as policies that aim to strengthen the productive structure of a particular national economy.[2]

In a broader sense, PDPs should be designed to improve the quality of the national business climate. As long as a sound business development and competitiveness-strengthening process is created, market forces should play the central role in the efficient allocation of productive resources and productivity growth. However, upgrading competitive capacity and shifting factors of production is time- and resource-consuming and requires substantial investment. Governments have a role to play in facilitating the resource-allocation process. The debate on the case for targeted interventions is based on the existence of various kinds of market failures or externalities, which would justify the design and implementation of industrial policies to enhance a country's productive capacity.

Costa Rica has been implementing PDPs for decades. During the 1960s and 1970s, it adopted PDPs based on industrial protection and the entrepreneurial state model. After the economic crisis of the early 1980s, Costa Rica did not abandon industrial policy interventions, but their scope and objectives changed. New PDPs shifted to the promotion of non-traditional exports to third markets (outside the Central American market), which implied a change in policy instruments, targeted sectors, and beneficiaries.

Aggregate productivity (total factor productivity—TFP) growth is a key factor for sustained economic growth. The evidence suggests that on average, Latin American countries are underperformers in terms of TFP growth when compared to developed countries and other successful developing nations (Ferreira et al., 2008). Costa Rica is no exception, notwithstanding its relative success compared to other countries in the region. Contrary to some outstanding developing country cases (e.g., Ireland, Chile, and the Asian Tigers) it seems that the sustained

[2] This definition includes any measure, policy or program aimed at improving the growth and competitiveness of large sectors of the economy (manufacturing, agriculture); specific sectors (textiles, automobile industry, software production, etc.); or the growth of certain key activities (research and development, exports, fixed capital formation, human capital formation).

productivity growth impact of PDPs in Costa Rica has not been as strong as necessary to catch up with global leaders in this area.

Monge-González and Hewitt (2008) argue that in order to create an innovation-driven economy and foster productivity, it is necessary to position Costa Rica among global leaders in the 12 pillars of competitiveness evaluated by the World Economic Forum.[3] The authors conclude that Costa Rica is facing important challenges in 10 of these 12 pillars.[4] These competitiveness disadvantages suggest limited effectiveness of current PDPs to address key issues related to the improvement of the business climate and productivity growth. Moreover, PDPs in Costa Rica emphasized selected interventions, narrow sector policies, and targeted instruments, instead of targeting basic requirements and creating market conditions to improve competitiveness.

Monge-González et al. (2010) studied whether PDPs in the last few decades have responded to market failures. In so doing, the authors: a) discussed whether existing PDPs are justifiable in terms of the market or government failures they address; b) evaluated the public sector's capacity to correct these failures (with a discussion of the adequacy of the institutional setting and agencies in charge of implementing these policies); c) made a political economy analysis of the main forces and interest groups influencing the design and implementation of selected PDPs; and d) elaborated a general proposal for policy reform and new directions for outcome improvements.

Even given the results of Monge-González et al. (2010), there is still a lack of knowledge about the real impacts on firm performance of the PDPs studied by the authors. Specifically, additional evidence is needed not only on the effectiveness of PDPs in achieving their primary expected outcomes, but also on a set of secondary questions that may play a key role in the design and fine-tuning of policy tools. It is for this reason that the present paper shows the results of an investigation on the impact of two PDPs already analyzed by Monge-González et al. (2010), specifically PROPYME (a program promoting R&D and other innovation activities) and Costa

[3] Institutions, Infrastructure, Macroeconomic Stability, Health and Primary Education, Higher Education and Training, Goods Market Efficiency, Labor Market Efficiency, Financial Market Sophistication, Technological Readiness, Market Size, Business Sophistication, and Innovation.

[4] The only two pillars where Costa Rica is not facing strong challenges are Primary Education and Labor Market Efficiency. In both areas, effective policies have been implemented for decades. The global competitiveness rankings confirm this outcome (World Economic Forum, 2008).

Rica Provee (a program that promotes backward linkages between multinationals and local firms).

We study the impact of these two programs in ways that go beyond the average treatment effects on the treated (ATT) usually estimated in the existing literature. Specifically, the research focuses on the identification of (a) the timing or dynamic effects (i.e., how long should we wait to see results?); (b) treatment intensity (dosage effects); and (c) the complementarities or substitution effects among the two programs. The project thus provides additional evidence that is crucial to the review of these existing PDPs in order to improve their current results.

This document is organized in four sections, including the introduction. Section 2 describes the main characteristics of the PROPYME and CR Provee programs and their expected results. Section 3 presents the methodology employed to estimate the impact of both programs, including the identification strategy. Section 4 offers the main conclusions and a summary of the policy implications stemming from the whole work.

2. PROPYME and CR Provee: Interventions and Expected Effects

Before evaluating the impact of the PROPYME and CR Provee programs, it is important to discuss their origins, institutional settings, the rationale for policy intervention, their aggregated outcomes, and the expected effects on beneficiary firms.

2.1 R&D and other Innovation Activities: the PROPYME Program

2.1.1 Origins

The idea of supporting investment in research and development (R&D) of SMEs originated almost two decades ago, with the Law on the Promotion of Scientific and Technological Development (Law 7169) in 1990, which created 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, Fondo de Recursos Concursables) was created. Its objective was to promote R&D in SMEs (companies with fewer than 100 employees) and enhance management capacities and competitiveness. The FRC was developed by MICIT, CONICIT, and the Presidency (through the so-called *Programa Impulso*).

The main reasons for the creation of this fund were the following:

- To stimulate technological innovation at international economy levels.
- To carry out the State's responsibility for creating the conditions for science and technology to contribute to the improvement of the quality of life of Costa Ricans.
- To allocate financial resources to promote investment in R&D in SMEs.
- To support research units (RUs) as a key element in developing the productive sector of the country.

The FRC was modified in May 2002 by Law 8262 (Law on the Strengthening of SMEs). A new fund called PROPYME (Programa de Fortalecimiento para la Innovación y Desarrollo Tecnológico de las PYMES) was established to promote entrepreneurship and competitiveness of Costa Rican SMEs through innovation and technological development, and to contribute to economic development.[5]

The Economic Affairs Commission of the Congress concluded that SMEs required an integrated PDP to enhance systemic competitiveness and correct several distortions resulting from obsolete infrastructure, burdensome red tape and business creation costs, wide interest rate spreads, expensive public services and an inefficient tax system. The Commission supported Law 8262 based on a study that pointed out critical obstacles to SME growth, namely:

- Limited access to market intelligence and advanced technologies
- Limited coordination among sectors
- Scarce resources for productive, R&D and training investments
- Limited access to financing due to guarantees and other banking requirements
- Low production volumes and quality standards which impede access to international markets
- Lack of entrepreneurial capabilities and limited managerial skills
- Limited support of current PDPs for SMEs

The Commission argued that promoting SMEs required a public policy to improve systemic competitiveness. In this context, and after reviewing the WTO Agreement on Subventions and Compensatory Measures (SCM), the Commission concluded that subsidies to

[5] This program is based on the principle of demand-driven support, and as such does not target specific sectors.

correct evident market failures or those situations where high shadow costs exist (government failures) were permissible.

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 Ministry of Science and Technology (MICIT), and are managed by the National Council for Scientific and Technological Research (CONICIT).[6] 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
- 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).[7] The RUs present their offers for projects that qualified in the first stage. The winning offers are selected according to quality, capacity,

[6] The members of this Commission are the Minister of Science and Technology, three representatives from CONARE, one representative from the Ministry of Agriculture, one representative from the Ministry of Economy, Industry and Commerce (MEIC), two representatives from the Ministry of Finance, one representative from the Chamber of Industries (CICR), one representative from CONICIT, and one representative from the Costa Rican Union of Chambers of the Private Sector (UCCAEP).

[7] The RU may belong to either a public or private university from 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).

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 funds from PROPYME jointly with the RU of its choosing, from the beginning of the process. The third change was reducing the time period in which CONICIT decides whether to approve an application from a business, which now will be a maximum of 30 natural days.[8] A fourth change was to make individuals eligible for PROPYME funds. A fifth reform is that beneficiaries can participate in preparing the final draft of the agreement with MICIT for the use of PROPYME resources. Finally, a program of technological managers was created, to provide support to beneficiary businesses during the application process for PROPYME resources.

2.1.2 Institutional Setting

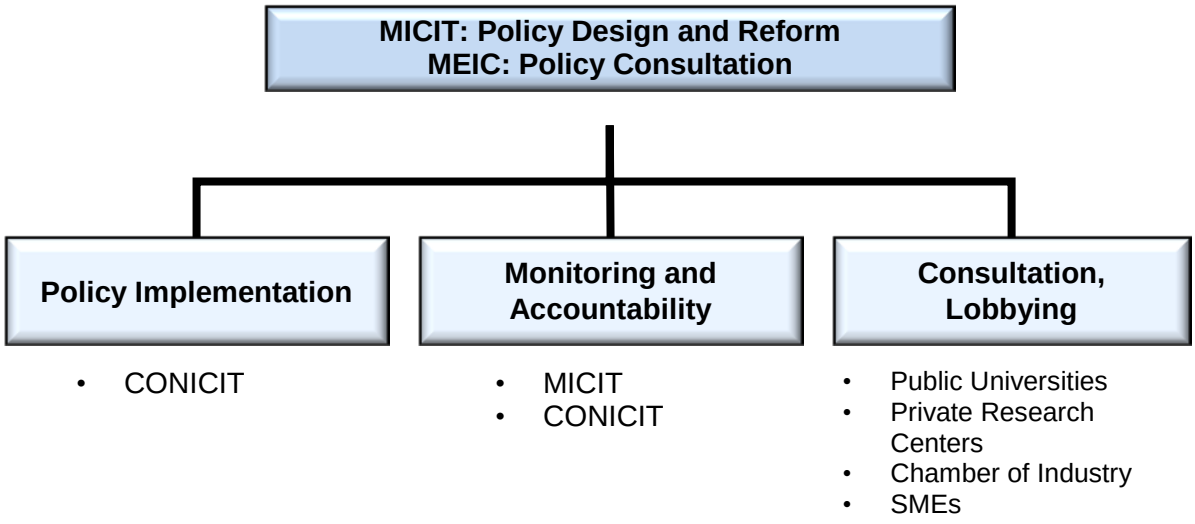
The Ministry of Science and Technology is responsible for PROPYME policy design and implementation and is directly involved in monitoring and accountability. In addition, the Ministry of Economy serves as a consultative body, the MEIC elaborates the general framework of this PDP, and CONICIT is responsible 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

[8] For businesses that present their application without the support of a research unit, this time period is extended to 45 days.

changes and improvements in regulatory mechanisms. The current institutional setting is described in Figure 1.

Figure 1. Institutional Setting of PROPYME



Source: Monge-González et al. (2010).

2.1.3 The Rationale for Policy Intervention

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. 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 from its investment because of the presence of positive externalities due to technological or knowledge spillovers resulting from the innovation.

Monge-González and Hewitt (2008) note that 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). This situation occurs when an innovative firm receives private marginal revenues

which are less than its social marginal revenues—when the knowledge the firm is generating 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 is 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 developing country governments because of 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.

Theoretical results from Arrow (1962) and Scherer (1967) suggest that more competition in a market should lead to greater levels of innovation and R&D investment.[9] 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. Since 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.

A final policy recommended by Martin and Scott (1998) 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). The Finnish Innovation Fund is an important example of how to combine the development of capital markets and the awarding of non-reimbursable public funds to assist the process of innovation, especially by SMEs.[10]

According to Rodríguez-Clare (2004), 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. In fact, the author states that 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.

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 allocation of resources. The correction of those failures is a necessary condition for improving the technological capabilities of SMEs.

[9] This point has been reinforced by Baumol (2002), who claims that firms use innovation as their main approach to competing in markets.
[10] See www.sitra.fi/en for more information.

2.1.4 Policy Outcomes

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.[11] In short, between 2003 and 2011, PROPYME supported 114 innovation projects carried out by 87 SMEs. The largest number of projects proposed were related to technological development, while the largest number 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 absence of funded projects aimed at registering patents is a clear limitation on innovation and productivity growth of Costa Rican firms.

Any policy intervention scheme aimed at increasing innovation activities by private firms must be supported by knowledge protection. Only in this way can the impact of activities like R&D investment on productivity growth be enhanced. Notwithstanding the existence of a legal and institutional framework in the country, it seems that PROPYME is not providing incentives for the acquisition of intellectual protection for innovations by its beneficiaries.

In Costa Rica, several factors account for the scant investment in R&D and innovation. One is that public universities prefer a supply-driven rather than a demand-driven innovation strategy. Another is that the Costa Rican educational system is not particularly oriented toward the promotion of entrepreneurship among students (Monge-González and Hewitt, 2008).

Interestingly, none of the firms interviewed by Monge-González et al. (2010) mentioned any need for funding to patent products, processes, or innovative ideas. According to Hausmann and Rodrik (2003), one possible explanation of this result is the low degree of technological sophistication resulting from the innovation process. This topic warrants further research.

Between 2003 and 2011, 114 projects were finally funded by MICIT, receiving a total investment of US$1.7 million during that period, with an average of US$15,067 allocated to each firm (Table 1). The average amount granted to technological development projects was US$27,930.

Based on the size of the grants given to innovation and technological development projects in other Latin American countries, such as Chile, Panama, and Uruguay,[12] Maggi et al.

[11] Some businesses abandoned the project for various reasons, most often because they were in disagreement with the research unit assigned to them for joint implementation of the project.

[12] In Chile, a project on innovation can receive up to US$870,000, while in Panama this amount can be up to US$250,000 and in Uruguay up to US$400,000.

(2012) suggest that Costa Rica should significantly increase the amount granted to firms for such projects. They recommend increasing the amount of grants for technological R&D from $29,924 to US$90,000 and innovation grants from US$22,950 to US$40,000. Costa Rica is actually investing very little through PROPYME to help domestic firms undertake innovation projects.

Returning to the analysis in Table 1, some firms received more than one grant during the same year in order to finance technological development, technological services, and human capital initiatives. This situation makes it impossible to analyze the effect of PROPYME by type of innovation activity that it was supporting in any given year.

On the other hand, some firms decided to not participate after they were 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 2 for the period analyzed. The sudden decline in the amount of funds approved in the last two years of the period analyzed (2010 and 2011) is notable.

Finally, preliminary data for 2012 show that the numbers of both approved and funded projects increased significantly during the year, and more than US$2.5 million—more than 10 times the amount allocated in the year 2011—was disbursed. This may well be due to recent changes in the rules implemented by the MICIT, but because of limitations in the currently available data, an investigation of this issue is beyond the scope of this research.

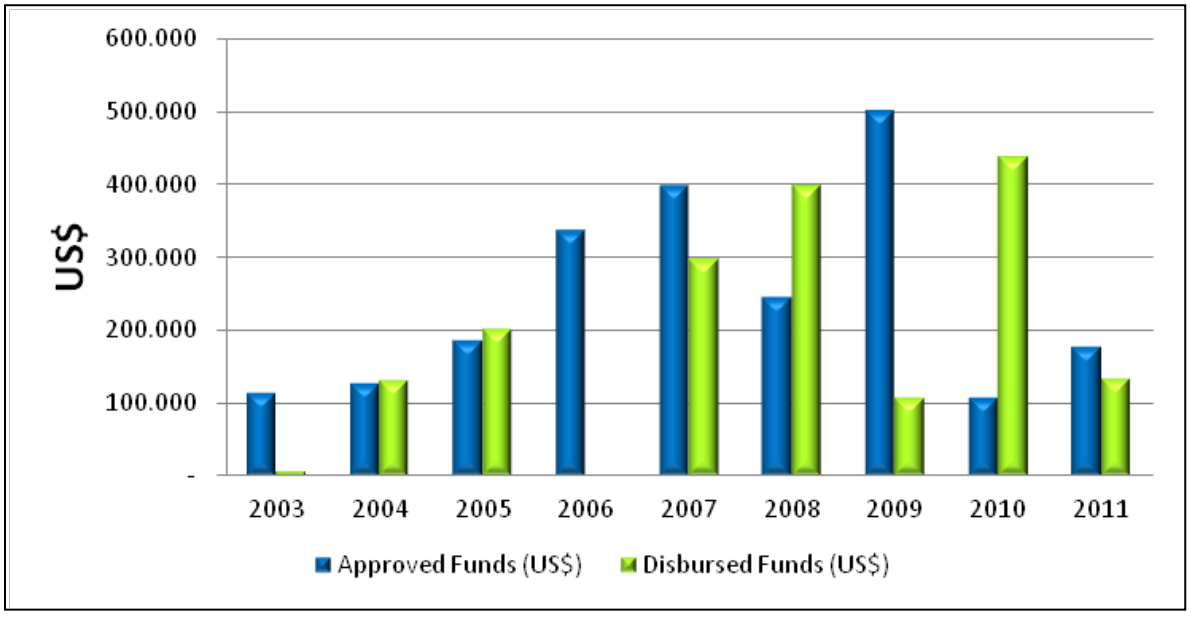
According to Monge-González et al. (2010), most managers of Costa Rican SMEs are unaware of the PROPYME program and are thus unable to take advantage of its financial instruments. Other companies indicate that they know about the program only indirectly, from information obtained from the Chamber of Industries. Once they learn what PROPYME does, the companies express their interest in applying, and stress the importance of this kind of policy to overcome weaknesses in technological and human capital.

Table 1. Total Amount of PROPYME Funds According to Type of Project by State of the Projects from 2003 to 2011

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.

Figure 2. PROPYME Funds by State per Year, 2003-2011



Source: Databases from CONICIT, 2003-2011.

Even though a project may be approved in a given year, it may not be implemented in that same year. This explains the differences between amounts approved and amounts disbursed during the period analyzed.

According to Monge-González et al. (2010), between 2003 and 2008 only 14 percent of all PROPYME projects funded were undertaken by local suppliers of MNCs. Based on this result and the need for innovation improvements by local suppliers of MNCs, a cooperative agreement was signed in 2012 between the Ministry of Foreign Trade (COMEX) and the MICIT to increase the use of PROPYME resources by these local suppliers. As a result of this effort, the total amount of available resources for 2012 in PROPYME was allocated, and more than 40 of the beneficiaries are local suppliers of multinational corporations (MNCs).

One of the most interesting projects funded by PROPYME is the training in the design, construction, and verification of structures in space received by the six PYMEs that created the Costa Rican Aerospace Alliance (CORAAL). Through this alliance, these firms participated in the construction of a model representing a platform which would work as an interface between a plasma engine and the International Space Station (ISS). This was achieved by contracting services from Ad Astra Rocket Company, which is constructing the plasma engine. Professors and students of precision mechanics and industrial electronics of the Vocational College of Arts and Crafts (COVAO) of Cartago also participated in this project.

2.1.5 Expected Impacts on Beneficiary Firms

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 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).

2.2 Costa Rica Provee: Backward Linkages between MNCs and Local Firms[13]

2.2.1 Origins

Since the creation of the export processing zone (EPZ) regime at the beginning of the 1980s, the promotion of productive linkages has been a subject of public interest, due to the weak vertical integration of Costa Rican industry.[14] This situation was a result of the inward-looking strategy of development based on import substitution during the 1960s and 1970s, which promoted the manufacture of final goods rather than raw materials and intermediate goods.

In the National Program of Science and Technology 1986-1990, there was a reference to this topic. Within the policies for the promotion of industrial development based on science and technology, the program indicated that the government would support the development of the technological capacity of local suppliers and public R&D organizations with the potential to satisfy the requirements of the private sector.

Notwithstanding the public interest, the initial efforts to develop local suppliers came from the private sector. Baxter Health Care, Inc., one of the first important MNCs established in Costa Rica, created a program of technical assistance to develop local suppliers in the mid-1990s as part of the firm's business strategy for the country.

In 1998, local authorities acknowledged the need to develop suppliers because of the low level of integration of MNCs operating in EPZs with local companies, and to improve Costa Rica's investment climate. As a result, a group of public and private organizations (CINDE, MICIT, PROCOMER, and Baxter) created the Local Industry Improvement Program (Programa MIL) to help local companies do more business with high-tech MNCs. Later, PROCOMER representatives proposed a more ambitious program called Business Linkages Support Program (Profeve), without success.[15]

Finally, in 1999, the Supplier Development Project for High-Technology Multinational Companies was created. This program was supported by the IDB and managed by FUNCENAT. [16] Its creation stemmed from a previous assessment that found important

[13] Most of this section is drawn from Monge-González et al. (2010).
[14] See File 7870 of the Export Processing Zones and Industrial Parks Law (Law 6695 of 1981).
[15] The Chamber of Industries and the Ministry of Industry (MEIC) did not support the proposal. They argued that industrial policy promotion was not part of PROCOMER's responsibilities.
[16] The High Technology National Center Foundation is part of the National Council of Rectors of public universities (CONARE). In addition to FUNCENAT, the Directive Committee of the program included the Chamber of Industries, CINDE and PROCOMER.

limitations for SMEs in doing business with high-tech MNCs due to low levels of technological sophistication, lack of entrepreneurship (especially in quality and risk management), difficulties with accessing credit and venture capital, limited productive infrastructure capacity, and ignorance of procurement practices, standards, and demand requirements of MNCs (Groote, 2005).

This PDP had as a general objective increasing the domestic value-added from high-tech MNCs and improving the technological capacity of SMEs to help them become indirect exporters to MNCs (local suppliers) to later export to foreign markets.[17] Government organizations acknowledged the urgent need to coordinate their work and create a national productive linkage program between SMEs and high-tech MNCs. The program had three components:

- A Procurement Pilot Program, with 45 successful linkages between SMEs and MNCs as the main goal (three years).
- An Integrated Information System to manage supply and demand data from SMEs, MNCs and supporting organizations (one and a half years).
- The creation of Costa Rica Provee (CRP), a National Supplier Development Office (which had to be legally constituted at the beginning of 2002).

Financing for the program was US$1.9 million, 60 percent from IDB non-reimbursable resources and 40 percent from Directive Committee members. The initial budget was ultimately reduced to less than US$1.3 million. This outcome was in part a result of the policy design, since the program targeted the upper layer of the pyramid of SME capacities classification, that is, those companies with more capabilities, less need for technical assistance, and therefore greater probability of successfully doing businesses with MNCs.[18]

The program was delayed for almost two years because of organizational and administrative difficulties. In 2004, the Directive Committee transferred Costa Rica Provee to the Costa Rican Foreign Trade Corporation (PROCOMER), to provide continuity for the program through consolidation within a well-funded organization, and to strengthen indirect exports to MNCs. Costa Rica Provee detects the needs of multinational companies, identifies business

[17] MNCs and SMEs were also part of the Directive Committee.
[18] For a detailed description see Paus and Gallagher (2008).

opportunities, and recommends partner suppliers that comply with the production, technical, and quality specifications and characteristics required by MNCs. The program has oriented its services toward three strategic business areas:

- Information & Communications Technology / Electrical - Electronics / Metal Mechanics Sector
- Medical / Chemical / Pharmaceutical Sector
- Agribusiness / Textiles

Costa Rica Provee turned into a more MNC demand-driven program, identifying the main requirements of inputs and raw materials from multinational companies, and then matching MNCs' demands with local suppliers. It also applied the concept of creating business opportunities through small projects between SMEs and MNCs, where the objective was to help local suppliers to rise in the value chain, ultimately becoming global suppliers.

Costa Rica Provee was not created by a law. Nevertheless, its activities are influenced by the EPZ Law and its regulations, particularly with respect to customs procedures. In fact, this law regulates the commercial relations between EPZ firms and local companies through two mechanisms:

- Direct purchase, when an EPZ company buys a final good or service from a local firm, without any contribution of raw materials, machinery, or equipment from the MNC to the local supplier.
- Outsourcing, when the EPZ company provides raw materials and even machinery and equipment to the local supplier to produce the final goods.

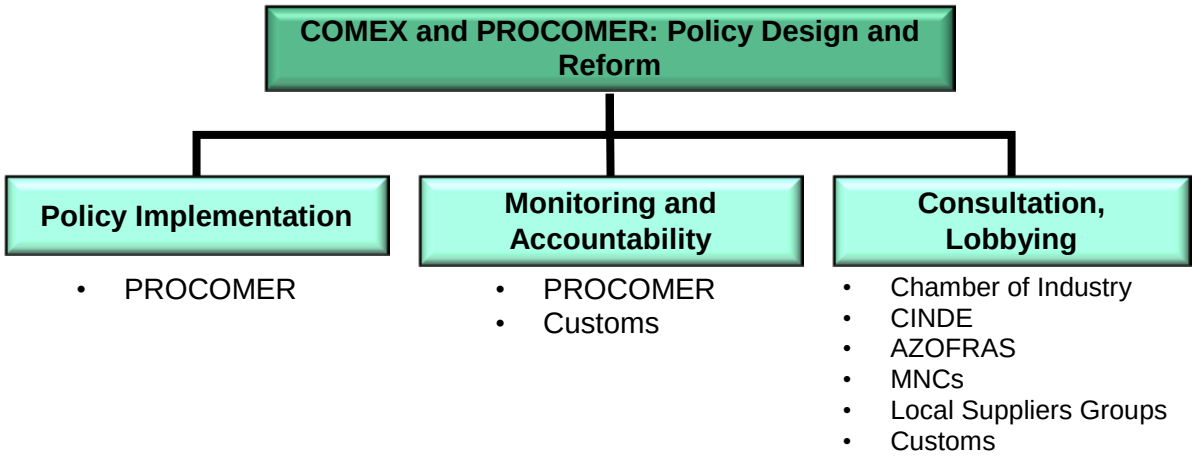
In the recent past (December 1999, June 2006, and August 2008), three important reforms to the EPZ Law related to linkages took place which made the aforementioned mechanisms more flexible. The most recent reform introduced important changes in outsourcing mechanisms. The share of maximum outsourcing increased from 25 to 50 percent of total MNC value-added, and the simultaneous contracting with different suppliers was permitted. In addition, the restriction of a maximum one year contracting term was eliminated. In addition, machinery and equipment were allowed to move outside EPZs (so that local suppliers could integrate them into the production process). Additionally, red tape and burdensome administrative procedures

were eliminated. Registration steps were reduced from 10 to 2, while approval time went down from 15-20 to 3 days.

2.2.2 Institutional Setting

Both public and private organizations have an influence on CR Provee. The institutional setting is described in Figure 3.

Figure 3 Institutional Setting of CR Provee



Source: Monge-González et al. (2010).

PROCOMER is responsible for the design and reform of CR Provee, which is influenced by the Ministry of Trade's actions regarding EPZ regulations. Implementation, monitoring, and accountability of CR Provee also fall under PROCOMER. A sizable group of private and public organizations are also related to CR Provee, with interests in the promotion of productive linkages between MNCs and local suppliers. The Customs administration has been a significant actor, aiming to creating efficient mechanisms to facilitate controls for trade between local companies and foreign firms in EPZs.

2.2.3 The Rationale for Policy Intervention

The literature indicates that the impact of foreign direct investment (FDI) on host-country economic development depends on associated technological and knowledge spillovers. In the latter case, such spillovers depend on vertical linkages, worker mobility, and demonstration effects between MNCs and local firms (Smeets, 2008). In the case of backward linkages,

knowledge spillovers from FDI that generate positive externalities on local industry might justify government intervention. However, success in attracting high-tech FDI does not automatically generate knowledge spillovers related to backward linkages. This also depends on MNCs' interest in sourcing inputs in the host country and the domestic linkage capability of that country. Therefore, backward linkage development must be approached both from the demand side (MNCs) and the supply side (local firms).

On the demand side, there are various points to consider, beginning with the sophistication of the MNC-branch productive process—more advanced processes could create more and higher value local linkages.[19] Secondly, in many cases CEOs of new MNC branches do not necessarily pursue linkages with local firms as part of corporate policy; initially, facilities construction and launching operations are the main priorities. With regard to procurement policy, local procurement managers frequently look for global suppliers instead of local firms for security reasons (productive process robustness). In addition, recently arrived local procurement managers usually lack knowledge of local capabilities. There are high costs associated with identifying local suppliers, and this represents an information asymmetry that limits local linkages (market failure).

However, CEOs have the target of productivity improvements for internal competitive reasons: a) to become the most productive MNC branch; and b) to import as many processes as possible from more advanced branches and headquarters. Therefore, in order to improve productivity and increase the sophistication of the MNC branch, developing local suppliers can be an important strategy to follow. These strategic decisions (to increase process sophistication and backward linkages) and the success of the MNC branch are subject to the quality of the national business climate, which requires policies that improve key competitiveness and growth drivers such as education, health, infrastructure, and financial markets development.

On the supply side, local firms are not necessarily capable of supplying goods and services to multinationals because of the lack of firm-level capabilities, such as entrepreneurship, technology, production scale, manageable risk, and financing. Even when local firms are competitive in becoming MNCs suppliers, host country absorption capacity also depends on systemic learning infrastructure, institutions, and government policies (Paus and Gallagher, 2008).

[19] If the required local skills are available.

Local firms, especially SMEs, face significant obstacles in searching for and identifying better business opportunities with more advanced companies (incomplete information). Potential high-value transactions and contracts with advanced MNCs are often out of reach for SMEs, even if they have basic productive skills that could be enhanced through specific investments. The identification of market opportunities may be costly for these companies (coordination failures). The required investment, and its financing, for technological upgrading to comply with MNC requirements can be yet another structural obstacle for local suppliers' cluster development.

When taking into account the potential for externalities created by FDI, support for linkages between foreign and local companies can generate positive outcomes. That is, government intervention could increase the probability of realizing those externalities, since they are not necessarily achieved unless local suppliers are effectively linked to MNCs.

Foreign direct investment can affect the development of domestic knowledge, mainly through technological spillovers. Spillovers can be classified as human capital effects (horizontal spillovers) and demonstration effects (vertical spillovers). Multinational companies make significant investments in training and capacity building for their employees. There is evidence that MNC employees leave these firms and move on to domestic firms (spillovers) or start their own businesses in the host country (spin-offs) (Moran et al., 2005; Monge-González et al., 2012). The movement of workers from MNCs to local firms constitutes a positive externality that could lead to higher wages for these workers and/or greater productivity for the firms that employ them (Poole, 2008; Monge-González et al., 2012).

When discussing backward linkages, Smeets (2008) makes a distinction between knowledge spillovers and knowledge transfers. Knowledge spillover at the firm level is defined as knowledge created by one firm (an MNC in this case) that is used by a second firm (a host-country firm), for which the host-country firm does not (fully) compensate the MNC. These potential benefits could justify government intervention to offset a market failure (externalities).

Technology and knowledge transfer, on the other hand, entail different kinds of costs. Some of them may be covered by MNCs interested in increasing local procurement and technological cooperation, but the bulk of technology improvement investments may not be funded by foreign companies and could be out of reach for local companies.

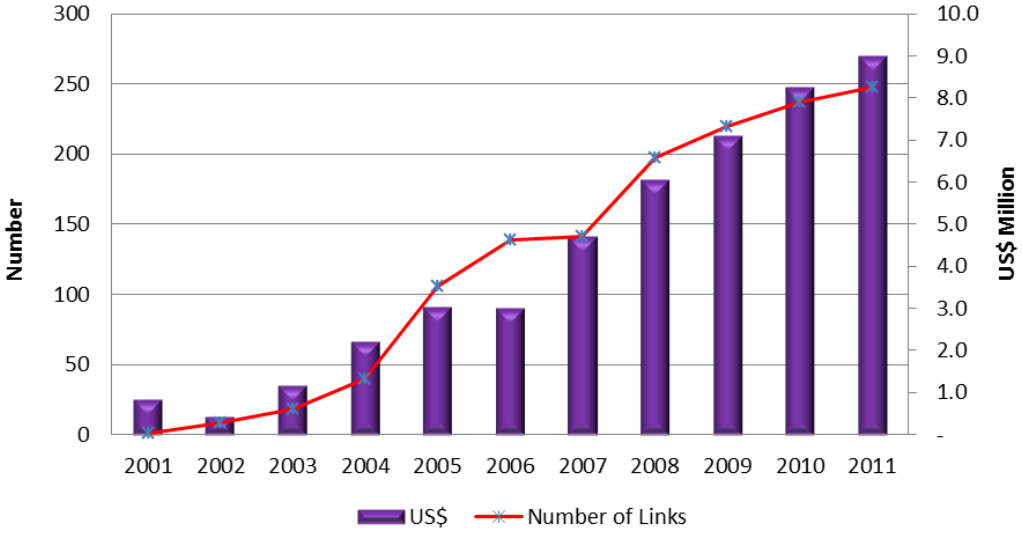
Based on the previous points, a national plan to promote productive linkages between MNCs and local firms can be seen as a response to specific market failures (coordination failures

among local companies) and externalities (from FDI). Thus, there are arguments for government intervention and PDP implementation. However, in the case of Costa Rica Provee, not all market failures have been addressed. Currently, the program addresses only information asymmetries between local firms and MNCs. That is, it helps to identify the actual demand for inputs and intermediate goods by MNCs, and searches for possible suppliers (business matchmaking). This is clearly an important task, but its full potential for business development (productivity improvement) cannot be realized unless other key issues, such as limited access to technology, financing, and lack of entrepreneurship are addressed by a national linkage-creation policy. In short, Costa Rica Provee is a PDP that does not address market failures optimally.

2.2.4 Policy Outcomes

Between 2001 and 2011, the number of backward linkages registered by Costa Rica Provee increased from 1 to nearly 248, representing US$0.8 million in sales in 2001 and US$9.0 million in 2011 (Figure 4). Groote (2005) found that only 17.3 percent of the linkages created by Costa Rica Provee were incorporated into the high-tech MNCs' final products. Thus, more linkages were related to non-specialized inputs. During the 2007-2009 period, the number of backward linkages increased significantly, from 141 in 2007 to 197 in 2008 and 220 in 2009. By 2011, the total number of linkages was 248. Throughout the 2001-2011 period, the program generated 1355 linkages between local firms and MNCs.

Figure 4. Productive Linkages Promoted by Costa Rica Provee



Source: Databases from COMEX and PROCOMER, 2001-2011.

Despite the positive results of Costa Rica Provee shown in Figure 2, according to Monge-González et al. (2010), the magnitude of its operations is very limited relative to the size of the Costa Rican economy and MNC purchases. For instance, total local purchases by MNCs in Costa Rica for 2007 accounted for US$591.1 million, while those promoted by Costa Rica Provee in the same year accounted for only US$4.7 million, that is, less than 1 percent. According to data from the Ministry of Finance of Costa Rica, approximately 9,654 local companies supplied different types of goods and services to MNCs that operated under the free zone regime, from 2001 to 2011. This number of local suppliers contrasts with the small number of CR Provee beneficiary firms during the same period—403 firms. Thus, the share of CR Provee beneficiary firms was only 4 percent of all local suppliers of MNCs.

Monge-Gonzalez et al. (2010) concluded that Costa Rica Provee emerged as a possible response to information and coordination market failures. The targeting of firms in specific areas reflects the belief that coordination failures impede effective cluster formation. However, the recognition of market failures did not lead automatically to the development of an effective national linkage capability. As indicated previously, before Costa Rica Provee, three programs to promote the creation of linkages were implemented in Costa Rica, but they were not properly coordinated, or were mostly "paper tigers." In order to assess the extent to which beneficiary firms are already obtaining better performance thanks to this program, the authors recommended carrying out an impact evaluation.

Flores (2011) presents empirical evidence on whether or not Costa Rica Provee has helped to develop backward linkages between high-tech multinationals (HT-MNCs) and local firms. He evaluates the relation of being part of Costa Rica Provee and having achieved backward linkages with higher asset specificity. Using the MNC as subject of study, he estimates some econometric models using data from a panel of 94 HT-MNCs from 2001 to 2008. The empirical results do not provide robust evidence of a positive effect of Costa Rica Provee on the generation of backward linkages between the HT-MNCs and local suppliers.

Saggi (2002) emphasizes that the extent to which FDI contributes to knowledge and technological spillovers depends on the trade policies adopted by the host country. In a more general framework, Paus (2005) shows the importance of dynamic interactions between the structure of MNCs' global value chain and local suppliers to reach an industrial upgrade of the host country. Paus and Gallagher (2008) point out that the potential of backward linkages

between MNCs and local firms depends on the absorptive capacity of knowledge spillovers by local firms.[20] Paus and Cordero (2008) claim that Costa Rica has not fully realized the potential of FDI for economic development, since backward linkages between MNCs and local firms are not as robust as they should be.

A final comment on the operation of the program during the period analyzed is in order. It can be argued that CR Provee has suffered from significant weaknesses, including its very low budget[21] and a lack of institutional coordination to provide beneficiary firms with other financial and non-financial services which would contribute to better performance and greater chances for success.

2.2.5 Expected Impacts on Beneficiary Firms

The IDB supported the creation of the Costa Rica Provee program, with the initial objective of helping increase Costa Rican value-added in the production of high-technology MNCs corporations operating under the free zone regime, thus increasing the technological capacity and competitiveness of SMEs and helping them to increase their exports.[22] With this objective in mind, it would be expected that, over time, beneficiary businesses of CR Provee would perform better and therefore demand more employment, pay higher wages, and increase exports. However, given the lack of knowledge-absorptive capacity by local suppliers (Paus, 2005) it is possible that such outcomes are not being achieved. On the other hand, according to Vargas et al. (2010), between 2001 and 2008 there was an important increase in the volume of exports of Costa Rica Provee's beneficiary firms. Beneficiaries of this program state that they have benefitted from knowledge transfer in their relationship with MNCs that increased their competitiveness. However, there is no evidence from impact analyses showing that these effects are specifically caused by SMEs' participation in the CR Provee program. Our study estimates such impacts on employment, salaries and exports of beneficiary firms.

[20] The absorptive capacity of a firm is defined as the ability "to recognize the value of new, external information, assimilate it, and apply it to commercial ends" (Cohen and Levinthal, 1990).
[21] According to Procomer, during the last five years its annual budget has accounted for about US$260,000.
[22] According to the framework of the Project to Develop Suppliers for Multinational High-Technology Firms, ATN/ME-6751-CR, IDB.

3. Methodological Approach for Impact Evaluation of the PROPYME and Costa Rica Provee Programs

Based on the previous discussion, we analyze the impacts of the two PDPs, PROPYME and Costa Rica Provee, in ways that go beyond average treatment effects on the treated firms (ATT). In particular, we focus the analysis on the identification of (i) timing (or dynamic effects), (ii) treatment intensity (dosage effects), and (iii) complementarities or substitution effects. In short, we attempt to answer the following questions:

a) What are the individual impacts of both PROPYME and CR Provee on firm performance?
b) How long should we wait to see results from the intervention?
c) Are additional doses of treatment necessary?
d) Are there complementarities or substitution effects among the two programs?

Based on the existing literature on impact evaluation, we follow a quasi-experimental approach, which requires specific data on the two programs 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. We work with a different set of panel data for each one of these two programs.

Since beneficiaries of either PROPYME or CR Provee 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 use in carrying out the impact evaluations for each program is a combination of regression methods and propensity score matching that explicitly controls for differences in observable variables between groups and fixed effects models, which use data from before and after the program (treated and control groups) to account for certain types of unobserved heterogeneity.[23]

As is well known, 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

[23] This approach has been used by the authors in previous research to evaluated the impact of having access to financial services (such as invoice discounting, purchase orders, and others), together with training courses of short duration provided by a microfinance institution to improve the performance of SME clients in Costa Rica (Monge-González and Rodríguez-Alvarez, 2012).

firm had not participated in the program (Storey, 2004). Since the hypothetical scenario cannot actually be seen, the challenge of impact evaluations consists of 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. The selection of this 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.

3.1 Strategy for Identifying the Control Group

This study intends to estimate the impact of both the PROPYME and CR Provee programs. Each program treated micro, small, and medium-sized firms between 2004 and 2011.[24] Since none of the firms in the panel data received funds between 2001 and 2003 (because the program did not yet exist), these years are considered the base, or pre-treatment, years for the purposes of this analysis.

As discussed later, two separated sets of panel data for Costa Rican SMEs were created for the impact evaluations. These two sets of panel data allow us to identify beneficiary firms of PROPYME and/or CR Provee funds, before and after they had access to these resources, as well as firms that did not receive such funds (i.e., treated and control firms).

To estimate the impact of both programs on SME performance, we combine the propensity score matching (PSM)[25] method with the fixed-effects model. While PSM makes it possible to control for selection bias attributable to observable characteristics of the firms, 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

[24] Since a very few firms were treated by CR Provee during the year 2003, we do not consider them in the analysis. This choice allows us to evaluate the operation of both programs since 2004.

[25] 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 (Tan et al., 2007).

on a firm's decision to receive funds from PROPYME or CR Provee, or on its performance over time.[26]

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 or CR Provee 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 beneficiary of PROPYME (or CR Provee) at least one time during the 2004-2011 period, and 0 if it was never a beneficiary.

PSM estimates the probability of participation of a firm in the PROPYME (or CR Provee) funds (regardless of whether the firm is a beneficiary of the program or not) 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 which 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 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 beneficiary of PROPYME, given the values of a set of observed variables X, which is expressed as:

$$p(x) = P(D = 1 \mid X = x) = E(D \mid X = x)$$

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 if the fact that 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

[26] 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-Acevedo 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.

effect of the treatment (PROPYME funds or CR Provee) on beneficiary firms (*ATT*) may be specified through the equations:

$$ATT = E[Y_1 - Y_0] = E[E[Y_1 - Y_0 \mid p(x)]]$$

and

$$E[Y_1 \mid p(x), D = 1] - E[Y_0 \mid p(x), D = 0] = E[Y_1 - Y_0 \mid p(x)]$$

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

The impact of either PROPYME or CR Provee 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 estimate the programs' impact by using the PSM results to define the treatment and control groups in a way that meets the common support condition and use the procedure of estimation of the impact equations (to be explained later) through a regression method using the fixed effects approach.

3.2. Specification of the Models and Estimation Procedure

To estimate the impact of PROPYME or CR Provee on SME performance, we apply a set of regression models to two sets of panel data (one for each program) 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*) some time in that period. For the case of wages and employment, we derive the model specifications assuming that Costa Rican SMEs display profit-maximizing behavior. For a detailed discussion of these two models, see Appendices 1 and 2, respectively. In these two cases, the estimation was conducted using ordinary least square (OLS), using both fixed-effects and propensity score

matching (PSM) plus fixed-effects approaches.[27] 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.[28] In this last case, both fixed-effects and PSM plus fixed-effects approaches were used.

In short, the three equations we estimate are the following:

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

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

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

where (*w-p*) is the average real wage paid by the firm (in logs), *PREM * 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 zero otherwise, and *X* the covariates. Each error term in equations (1), (2) and (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 estimate 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 do not use the fixed-effect approach in the estimation of this new specification.

In addition to estimating equations (1), (2) and (3), we explore the timing of the effects and if dosage is really important, following Crespi et al. (2011). In doing so and for the case of timing of effects, we modify the above three equations, substituting for the impact variable ***D*** another dummy called *D_timing*. This new dummy takes the value of 1 for all the years since the first intervention and 0 otherwise. For dosage effect, we substitute for the impact variable ***D*** another variable called *D_dosage*, 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

[27] In the case of equation (2) due to endogeneity problems with *(w-p)* as co-variable, what we estimate was a *reduced form* of the full equation derived in Appendix 2.

[28] 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.

year the firm was treated and until the year before the third treatment, and so on, and 0 otherwise. In other words, we are considering the case in which a firm was beneficiary in more than one year.

Finally, the complementarities or substitution effects between CR Provee and PROPYME are also explored. The findings of Monge-González et al. (2010) are relevant here. In the first place, the authors found that one of the problems most recurrently indicated by beneficiary firms of CR Provee for increasing their linkages with multinationals was the lack of financing for technological improvements. Secondly, very few beneficiary firms of CR Provee were also beneficiaries of the PROPYME program, and most beneficiaries of CR Provee did not know about the existence of the PROPYME program to obtain support for their technological and innovation efforts. The authors therefore recommended that firms that benefited from CR Provee that require resources for technological improvements should receive appropriate support from the PROPYME program.

In order to study the extent to which there are complementarities between CR Provee and PROPYME, the most straightforward approach, following that used in Monge-González and Rodríguez-Alvarez (2012), is to use a panel data model adding dummies for each treatment, and including interaction terms. Thus, for the two programs under consideration, CPR (for CR Provee) and PRP (for PROPYME), equations (1), (2), and (3) can be rewritten as follows:

$$(w-p)_{it} = \theta_0 + \theta_1 (PREM * SE)_{it} + \theta_2 CRP_{it} + \theta_3 CRP\&PRP_{it} + \theta_4 X_{it} + \tau_{it} \quad (4)$$

$$l_{it} = \vartheta_0 + \vartheta_1 CRP_{it} + \vartheta_2 CPR\&PRP_{it} + \vartheta_3 X_{it} + \omega_{it} \quad (5)$$

$$exp_{it} = \rho_0 + \rho_1 CRP_{it} + \rho_2 CRP\&PRP_{it} + \rho_3 X_{it} + \epsilon_{it} \quad (6)$$

where CRP is a dummy variable equal to one when the firm is a beneficiary of CR Provee and zero otherwise; while CRP&PRP is the interaction term. CRP&PRP has a value of 1 if the firm is simultaneously a beneficiary of both the CR Provee and PROPYME programs, and 0 otherwise. We do not include the variable PRP in equation (4), or those in in equations (5) and (6), since none of the rest of the firms in the set of panel data used in these estimations was a beneficiary of the PROPYME program.

In this context, the coefficient θ_2 in equation (4) captures the individual effect of CR Provee treatment, that is, the mean difference between units that participate in the CR Provee program and the untreated units:

$$\theta_2 = E(Y|\ CPR = 1, X) - E(Y|CRP = 0, X)$$

where Y denotes $(w - p)_{it}$ and X the covariates.

The coefficient θ_3 captures the interaction effect of the two programs (CR Provee and PROPYME). Specifically:

$$E(Y|CRP\&PRP = 1, X) - E(Y|CRP\&PRP = 0, X) = \theta_3$$

Thus, if $\theta_3 = 0$, the effect of simultaneous participation in both programs is simply the individual effect θ_2, while $\theta_3 > 0$ indicates the presence of a positive interaction effect. This means that being a beneficiary of both programs simultaneously will have a positive impact on firm performance, greater than if a firm is a beneficiary of CR Provee only.

Once again, the challenge in the estimation of equation (4) (as well as 5 and 6) lies in estimating the coefficients $\theta_2\ and\ \theta_3$ while eliminating any bias derived from the selection of untreated firms affected by the effects of complementarities due to observed and unobserved variables. We therefore combined the method of regression with fixed effects with the matching method—propensity score matching—to avoid this type of bias. Equation (6) will be estimated as a linear probabilistic model instead of a Probit or logistic model.

Since the fixed-effect approach assumes that non-observable attributes are fixed over time, it is important to test this assumption. In order to do so, we test if there were parallel pretreatment trends in the dependent variables. Considering that firms entered into either PROPYME or CR Provee programs from 2004 or any year after, we generated three pre-treatment dummies (PD): for one, two, and three years before the treatment happens. Thus, based on equation (1) we estimate equation (7) to test the validity of the parallel pretreatment trends assumption:

$$(w - p)_{it} = \beta_0 + \beta_1\ (PREM * SE)_{it} + \beta_2 D_{it} + \sum_{r=1}^{3} \delta_r\ PD_{ir} + \beta_3 X_{it} + \pi_{it} \qquad (7)$$

where the anticipatory effects (PD) are the pre-treatment dummies defined above. They should reveal any deviation in the assumption of parallel pretreatment trends. If the values of the coefficients are not significant, or are significant but with different values among them, it means that the assumption of parallel pretreatment trends is invalid. If this is the case, we proceed to

estimate equation (8) instead. This is a least square dynamic model where we include as co-variables three lag values of the dependent variable (one, two and three years), instead of fixed-effects approach.

$$(w-p)_{it} = \beta_0 + \beta_1 \, (PREM * SE)_{it} + \beta_2 D_{it} + \sum_{r=1}^{3} \gamma_r \, (w-p)_{it-r} + \beta_3 X_{it} + \mu_{it} \qquad (8)$$

3.3 Data

We collected information on the beneficiaries of both PROPYME and CR Provee, 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. The ID of each beneficiary was obtained from the Ministry of Science and Technology (MICIT) and from the Ministry of Foreign Trade (COMEX). Social security data comes from the Costa Rican Social Security System (Caja Costarricense del Seguro Social). Data on firm exports (a dummy) was supplied by the National Export Promotion Agency (PROCOMER). PROPYME and CR Provee started their operations around 2004. Given the availability of data from the CCSS, data were collected from 2001 to 2011. This guaranteed a panel of 11 years for both the treated and the control groups. Data periodicity is on an annual basis. We also obtained similar data for a significant number of other SMEs that were not beneficiaries of either PROPYME or CR Provee during the same period. Based on all this information, we constructed two sets of panel data—one for PROPYME (treated and untreated firms) and another for CR Provee (treated and untreated firms).

4. Results of the Impact Evaluation of PROPYME and Costa Rica Provee

In this section we discuss the results of the impact evaluation of the two PDPs under study. We first present the results for PROPYME, and then those for Costa Rica Provee. In both cases, the results were obtained using a fixed effects approach and a fixed effects plus propensity score matching approach. We used a least squared dynamic model when the fixed-effects approach was not valid. In all cases the impact of these two programs was estimated on three result variables: real average wages, labor demand, and exports. What was estimated was the average treatment on the treated (ATT).

4.1 Results of the PROPYME Impact Evaluation

Before showing the results of the impact evaluation of PROPYME, 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.

4.1.1 Estimation of the Propensity Score and Construction of the Common Support

Table 2 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 estimate 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 2 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 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 if 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 the model is 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.[29]

[29] 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.

Table 2. Estimation of the Probit Function for Propensity Score Matching, Measured in the Period 2001-2003

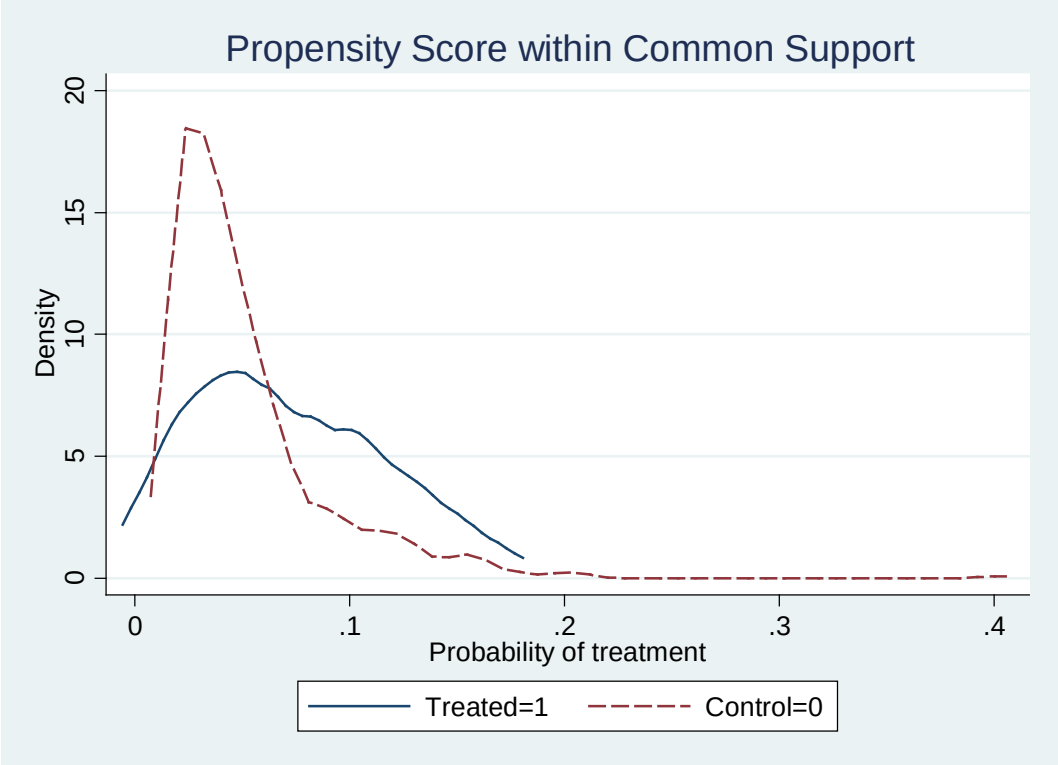
(Coefficient and P-Value)

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 chi2(9)	21.04
Prob > chi2	0.0125
Pseudo R2	0.0658

Note: * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.
Source: Authors' calculations.

Figure 5 shows the distribution of the propensity scores after matching for firms. That is, it shows the PSM results for firms in the treatment and control groups previously selected within the common support.

Figure 5. Density of Treated and Non-Treated Firms Resulting from the PSM in the Common Support for PROPYME's Impact Evaluation



Source: Authors' calculations.

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 3 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 that, for all the variables simultaneously, differences in mean between firms in the program and in the

control group are zero. 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 (Table 2).

Table 3. Balance in Observable Variables before and after Matching for PROPYME's Impact Evaluation

Variable	Sample	Treated	Control	Difference	S.E.	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.

4.1.2 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 participation of businesses in the program. This section discusses the results of estimations of equations (1), (2) and (3) using only the fixed-effects method, which is used to control for the behavior of non-observed variables. We also estimate equation (7) to test the parallel pretreatment trends assumption, and equation (8) it this is required according to the results from equation (7).

Since the businesses that benefit from PROPYME are PYMES, the sample for the study—beneficiary and control group businesses—was limited to only businesses that hire up to 100 workers.[30]

Results for real salaries (equation 1) are presented in Table 4. 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 4 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).

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 was 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 that 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 which benefit from PROPYME later continue on an innovative path which has a permanent impact on their performance. However, proving this hypothesis is beyond the scope of the present study.

[30] According to the classification of the Costa Rican Ministry of Economy, Industry, and Trade (MEIC), in which micro-businesses are those with 5 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.

Table 4. Impact of PROPYME Program on Real Average Wages
(Fixed effects and cluster-robust standard errors)

	(1)	(2)	(3)	(4)	(5)
Variables	**fixed effects**	**fixed effects**	**fixed effects**	**fixed effects**	**fixed effects**
D_t (Dummy equal to one if firm was treated in year t and zero otherwise)	0.1669***	0.0939***	0.0832***		
	(0.0432)	(0.0307)	(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***	0.0605***	0.0605***	0.0605***
		(0.0104)	(0.0104)	(0.0104)	(0.0104)
D_*timing*$_t$ (dummy variable equal to one for all the years since the first year the firm was treated, and zero otherwise)				0.1069***	
				(0.0335)	
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 zero otherwise)					0.0421***
					(0.0136)
Constant	13.7781***	13.1688***	13.1686***	13.1680***	13.1684***
	(0.0006)	(0.1051)	(0.1051)	(0.1050)	(0.1051)
Observations	11,444	11,444	11,444	11,444	11,444
R-squared	0.0018	0.3454	0.3455	0.3455	0.3453
Number of observations	2,048	2,048	2,048	2,048	2,048

Note: * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.
Source: Authors' calculations.

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 which 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 as complementary.

Although the results of the previous section suggest that participation of firms in PROPYME increased their productivity, it is pertinent to determine if the comparison group used is appropriate. It may be concluded from the discussion in Section 4.1.1 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 4 were estimated again controlling for fixed effects, but only for common support firms. These new estimations are considered to be more robust because firms which are not good "clones" of beneficiary firms are eliminated from the control group, according to the propensity score matching. Table 5 shows the results of the impact of PROPYME on real salaries, using the fixed-effects approach and propensity score matching (PSM), as well as testing for the parallel pre-treatment assumption.

In contrast to the results obtained in Table 4, those in Table 5 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 pretreatment 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 beneficiaries firms.

Table 5. Impact of PROPYME Program on Real Average Wages

(Propensity score matching, fixed effects and cluster-robust standard errors)

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	**PSM+fe**	**PSM+fe**	**PSM+fe**	**PSM+fe**	**PSM+fe**	**parallel pretreatment trends test**
D_t (Dummy equal to one if firm was treated in year t and zero otherwise)	0.0257	0.0115	0.0142			0.0085
	(0.0401)	(0.0275)	(0.0279)			(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***	0.0618***	0.0618***	0.0618***	0.0618***
		(0.0067)	(0.0067)	(0.0067)	(0.0067)	(0.0067)
D_*timing*$_t$ (dummy variable equal to one since the first year the firm was treated, and zero 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 zero otherwise)					0.0178	
					(0.0109)	
PD_1 (pre-treatment dummy equal to one for the first year before the firm was treated and zero otherwise)						-0.0131
						(0.0350)
PD_2 (pre-treatment dummy equal to one for the second year before the firm was treated and zero otherwise)						-0.0239
						(0.0450)
PD_3 (pre-treatment dummy equal to third for the first year before the firm was treated and zero otherwise)						0.0279
						(0.0391)
Constant	13.9370***	13.2806***	13.2806***	13.2804***	13.2805***	13.2808***
	(0.0004)	(0.0708)	(0.0708)	(0.0707)	(0.0707)	(0.0709)
Observations	5,235	5,235	5,235	5,235	5,235	5,235
R-squared	0.0001	0.3980	0.3980	0.3982	0.3983	0.3981
Number of observations	682	682	682	682	682	682

Note: * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.
Source: Authors' calculations.

4.1.3 PROPYME's Impact on Labor Demand

PROPYME's impact on labor demand (number of workers) according to equation (2) derived in Appendix 2, is presented in Tables 6 and 7. The results in the first of these tables refer to estimations using only the fixed-effects approach. From the first column of Table 6, 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).

Table 6. Impact of PROPYME Program on Labor Demand
(Fixed effects and cluster-robust standard errors)

	(1)	(2)	(3)	(4)
Variables	**fixed effects**	**fixed effects**	**fixed effects**	**fixed effects**
D_t (Dummy equal to one if firm was treated in year t and zero otherwise)	0.2540***	0.2188***		
	(0.0499)	(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 zero 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 zero otherwise)				0.1452***
				(0.0331)
Constant	2.0877***	2.0862***	2.0823***	2.0850***
	(0.0006)	(0.0010)	(0.0016)	(0.0014)
Observations	11,444	11,444	11,444	11,444
R-squared	0.0032	0.0044	0.0075	0.0051
Number of observations	2,048	2,048	2,048	2,048

Note: * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.
Source: Authors' calculations.

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 y 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)—the longer the firm receives treatment, the greater the impact on labor demand.

Finally, 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 productivity of that firm, shown by greater labor demand. In other words, longer dosages of treatment seem to increase productivity 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 7 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 propensity score matching are eliminated from the control group.

The results in Table 7 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 pretreatment variables in column 5 are significant, the fixed-effects approach is valid as an estimation procedure in this case. Thus, we can conclude that PROPYME has a positive impact on the labor demand of beneficiary firms of about 0.19 percent.

Table 7. Impact of PROPYME Program on Labor Demand

(Propensity score matching, fixed effects and cluster-robust standard errors)

	(1)	(2)	(3)	(4)	(5)
Variables	**PSM+fe**	**PSM+fe**	**PSM+fe**	**PSM+fe**	**parallel pretreatment trends test**
D_t (Dummy equal to one if firm was treated in year t and zero otherwise)	0.1976***	0.1878***			0.1897**
	(0.0732)	(0.0689)			(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 zero 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 zero otherwise)				0.0638**	
				(0.0314)	
PD_1 (pre-treatment dummy equal to one for the first year before the firm was treated and zero otherwise)					-0.0319
					(0.0959)
PD_2 (pre-treatment dummy equal to one for the second year before the firm was treated and zero otherwise)					0.0061
					(0.0882)
PD_3 (pre-treatment dummy equal to third for the first year before the firm was treated and zero otherwise)					-0.0432
					(0.0662)
Constant	2.3810***	2.3807***	2.3787***	2.3808***	2.3813***
	(0.0008)	(0.0010)	(0.0014)	(0.0012)	(0.0016)
Observations	5,235	5,235	5,235	5,235	5,235
R-squared	0.0025	0.0026	0.0032	0.0012	0.0026
Number of observations	682	682	682	682	682

Note: * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.
Source: Authors' calculations.

4.1.4 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 8 and 9. Table 8 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 in 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 also two years after the treatment. Indeed, the coefficients associated with these effects are positive and significant (0.0944 y 0.0688, respectively), as shown in the second column of Table 8.

Table 8. Impact of PROPYME Program on the Probability of Exporting: Linear Probability Model

(Fixed effects and cluster-robust standard errors)

	(1)	(2)	(3)	(4)
Variables	**fixed effects**	**fixed effects**	**fixed effects**	**fixed effects**
D_t (Dummy equal to one if firm was treated in year t and zero otherwise)	0.0876***	0.0944***		
	(0.0252)	(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 zero 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 zero otherwise)				0.0256*
				(0.0133)
Constant	0.1226***	0.1223***	0.1216***	0.1227***
	(0.0003)	(0.0004)	(0.0006)	(0.0005)
Observations	11,444	11,444	11,444	11,444
R-squared	0.0027	0.0036	0.0032	0.0011
Number of observations	2,048	2,048	2,048	2,048

Note: * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.
Source: Authors' calculations.

Another interesting result of this analysis is that the longer a firm has been treated, the greater the impact on the probability of its exporting. The coefficient associated with the dynamic effect of the intervention (D_*timing*) shown in the third column of Table 8 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 8. Thus, as shown in Table 9, 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 9, the parallel pretreatment trends assumption is valid since all of the coefficients associated with pretreatment 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.

As a general conclusion, it can be argued that PROPYME has had a positive impact on employment and the probability of exporting of beneficiary firms, but not on the real average wage of their employees, and that the time elapsed from initial participation and dosage is important in terms of determining the impact of the program. These results are very encouraging, taking into account that the operations of the program during the period analyzed suffered from important weaknesses, such as lack of flexibility in selecting a partner with which to execute the project, the ability to enter into the program throughout the year, the lack of coordination with other important programs such as CR Provee, and others. Considering that the Costa Rican

authorities have improved the way in which this fund operates based on regulatory reforms introduced in 2012, the impact of PROPYME can be expected to continue to be positive, and it will benefit many more SMEs interested in implementing innovative activities.

Table 9. Impact of PROPYME Program on the Probability of Exporting: Linear Probability Model

(Propensity score matching, fixed effects and cluster-robust standard errors)

	(1)	(2)	(3)	(4)	(5)
Variables	**PSM+fe**	**PSM+fe**	**PSM+fe**	**PSM+fe**	**parallel pretreatment trends test**
D_t (Dummy equal to one if firm was treated in year t and zero otherwise)	0.0859**	0.0960**			0.0813**
	(0.0383)	(0.0423)			(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 zero 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 zero otherwise)				0.0206	
				(0.0159)	
PD_1 (pre-treatment dummy equal to one for the first year before the firm was treated and zero otherwise)					0.0364
					(0.0421)
PD_2 (pre-treatment dummy equal to one for the second year before the firm was treated and zero otherwise)					-0.0136
					(0.0240)
PD_3 (pre-treatment dummy equal to third for the first year before the firm was treated and zero otherwise)					-0.0866
					(0.0699)
Constant	0.1532***	0.1530***	0.1528***	0.1534***	0.1534***
	(0.0004)	(0.0005)	(0.0007)	(0.0006)	(0.0004)
Observations	5,235	5,235	5,235	5,235	5,235
R-squared	0.0019	0.0023	0.0012	0.0005	0.0028
Number of observations	682	682	682	682	682

Note: * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.
Source: Authors' calculations.

4.2 Results of the Costa Rica Provee Impact Evaluation

As in the case of PROPYME, before showing the results of the impact evaluation of CR Provee 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.

4.2.1 Estimation of the Propensity Score and Construction of Common Support

Table 10 shows the variables that were included in the estimation of the propensity score for the sample firms as well as the results of the estimation. We estimate the probability that firms participated in the program between 2004 and 2011 using the firm's 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 10 to identify firms that did not participate in the CR Provee program but that have the closest propensity score values to firms that did participate in the program. Variables in the participation model include: geographical location (three provinces where most of the MNCs' local suppliers are located); sector of economic activity (lithographic process, since this is the most common input provided by local suppliers to MNCs); and some firm characteristics, such as number of workers, average wage, and a dummy variable that indicates whether the firm exported in 2002.

All of the coefficients included in the equation are significant. In addition, the model as a whole is also significant, and therefore the model is appropriate for the estimation of the probability of a firm—either in the treatment group or in the control group—participating in the CR Provee program. To achieve common support, it is necessary to eliminate the 20 percent of observations which have the lowest density in the participation probability.

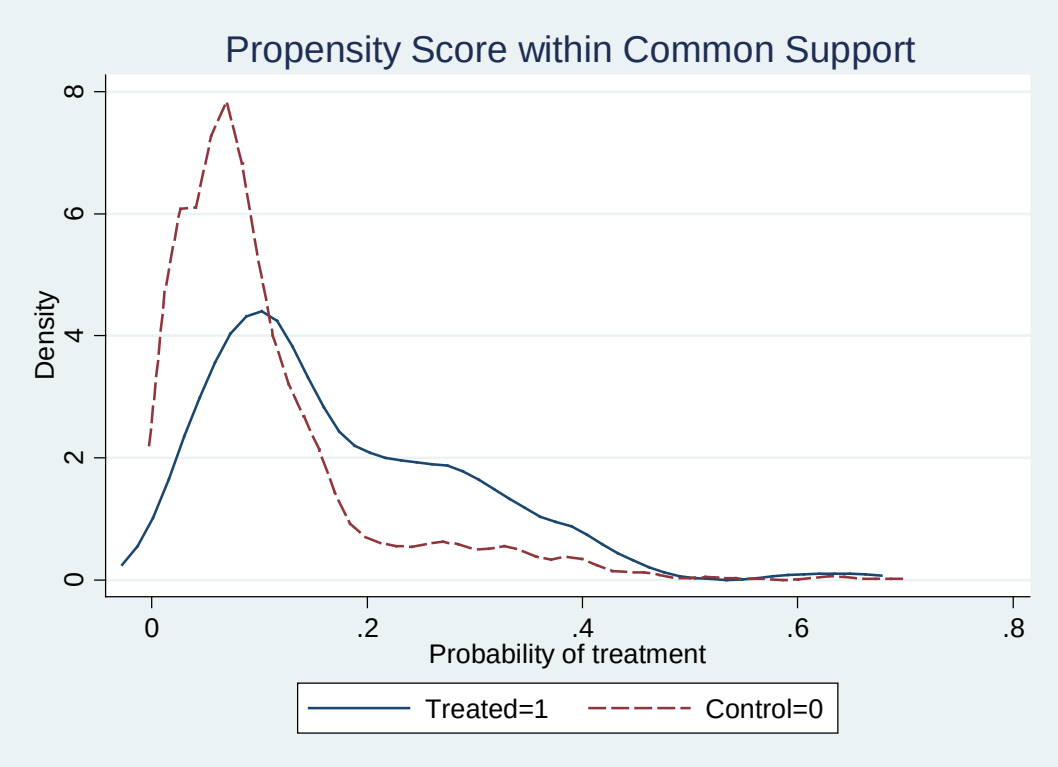
Table 10. Estimation of the Probit Function for Propensity Score Matching, Measured in the Period 2001-2003
(*Coefficient and P-Value)*

Variables	Coefficients
Firm is located in San José	0.6280***
	(0.1544)
Firm is located in Cartago	0.8718***
	(0.1894)
Firm is located in Heredia	0.7408***
	(0.1846)
Lithographic process	0.8663***
	(0.2429)
Firm exported in the year 2002	0.5457***
	(0.1312)
Real salaries in 2001 (logs)	0.1369***
	(0.0323)
Labor growth b/w 2001 and 2003	0.2010*
	(0.1058)
Constant	-4.2812***
	(0.5299)
Number of observations	1,670
Wald chi2(7)	100.20
Prob > chi2	0.0000
Pseudo R2	0.1058

Note: * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.
Source: Authors' calculations.

Figure 6 shows the distribution of the propensity scores after matching for firms. That is, it shows the PSM results for firms in the treatment and control groups previously selected within the common support.

Figure 6. Density of Treated and Non-Treated Firms Resulting from the PSM in the Common Support for CR Provee's Impact Evaluation



Source: Authors' calculations.

After identifying the firms that are included in the control group—that is, 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 (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 11 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 that, for all the variables simultaneously, differences in mean between firms in the program and in the

control group are zero. 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 (see Table 10).

Table 11. Balance in Observable Variables Before and After Matching for CR Provee's Impact Evaluation

Variable	Sample	Treated	Control	Difference	S.E.	T-stat
Firm is located in San José	Unmatched	0.61074	0.53386	0.07688	0.04276	1.80
	Matched	0.61667	0.62500	-0.00833	0.06786	-0.12
Firm is located in cartago	Unmatched	0.14765	0.09599	0.05166	0.02581	2.00
	Matched	0.15000	0.14167	0.00833	0.04945	0.17
Firm is located in Heredia	Unmatched	0.18121	0.12032	0.06089	0.02844	2.14
	Matched	0.15833	0.20000	-0.04167	0.05338	-0.78
Firm exported in year 2002	Unmatched	0.26846	0.08284	0.18562	0.02529	7.34
	Matched	0.17500	0.15833	0.01667	0.04846	0.34
Litographic process	Unmatched	0.07383	0.01512	0.05870	0.01204	4.87
	Matched	0.00833	0.00000	0.00833	0.00833	1.00
Real salaries in 2001	Unmatched	16.72404	15.81788	0.90617	0.13314	6.81
	Matched	16.59053	16.59801	-0.00749	0.20257	-0.04
Labor growth b/w 2001/2003	Unmatched	0.10335	0.08817	0.01518	0.03800	0.40
	Matched	0.12301	0.05486	0.06815	0.05586	1.22

Source: Authors' calculations.

4.2.2 CR Provee's Impact on Real Average Wages

As mentioned previously, it is necessary to control for observable and non-observable variables whose behavior may affect the result variable, as well as participation of firms in the program, to correctly estimate the impact of the CR Provee program. This section discusses the results of estimations of equations (1), (2), and (3) using only the fixed-effects method, which is intended to control for the behavior of non-observed variables.

Since the beneficiary firms of CR Provee are SMEs, the study sample was limited—for both beneficiary and control group firms—to businesses that employ up to 100 employees.

Results for real wages (equation 1) are presented in Table 12. The second column shows a positive and significant result for the treatment variable *–D-* (0.1212), which suggests that participation of firms in CR Provee has a positive and significant impact on the real wages that they pay to their employees. A comparison of the first and second columns of Table 12 also shows that the salary premium for differences in labor categories (Prem*SE) has a positive and significant coefficient (0.0775).

It is also interesting to note, in column 3, that the impact of participating in CR Provee is not only experienced during the same year when the treatment was applied, but also one and two years later (coefficients associated with D_{t-1} and D_{t-2} are positive and significant: 0.1462 and 0.1473, respectively). Thus, it seems that the commercial relationship among these firms and multinational corporations provides an important benefit for SMEs which may be related to the transfer of knowledge from multinational corporations to SMEs that participate in the CR Provee program (Monge-González and Rodriguez-Alvarez, 2012).

Table 12. Impact of CR Provee Program on Real Average Wages
(Fixed effects and cluster-robust standard errors)

	(1)	(2)	(3)	(4)	(5)
Variables	**fixed effects**	**fixed effects**	**fixed effects**	**fixed effects**	**fixed effects**
D_t (Dummy equal to one if firm was treated in year t and zero otherwise)	0.0780***	0.1212***	0.1304***		
	(0.0181)	(0.0157)	(0.0155)		
D_{t-1} (lagged treatment variable one year)			0.1462***		
			(0.0173)		
D_{t-2} (lagged treatment variable two years)			0.1473***		
			(0.0207)		
Prem * SE (Wage premium due to different labor categories)		0.0775***	0.0781***	0.0793***	0.0792***
		(0.0052)	(0.0052)	(0.0053)	(0.0053)
D_*timing*$_t$ (dummy variable equal to one since the first year the firm was treated and so on, and zero otherwise)				0.3300***	
				(0.0201)	
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 zero otherwise)					0.1659***
					(0.0139)
Constant	13.8197***	13.4258***	13.4188***	13.4057***	13.4080***
	(0.0003)	(0.0263)	(0.0267)	(0.0275)	(0.0274)
Observations	26,082	26,082	26,082	26,082	26,082
R-squared	0.0006	0.1627	0.1658	0.1716	0.1712
Number of observations	4,628	4,628	4,628	4,628	4,628

Note: * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.
Source: Authors' calculations.

When D_*timing* is replaced by the treatment variable, and dynamic (non-linear) effects of participation in CR Provee are analyzed (column 4), the results indicate that the longer the time a firm is treated, the greater the impact. In fact, the coefficient associated with D_*timing* is positive and significant (0.3300). This result may be suggesting that beneficiary firms of CR Provee continue to take advantage of the knowledge acquired from their commercial relationship with multinational corporations, which has a permanent impact on their performance.

Finally, the results in column 5 for treatment dosage (D_*dosage*) suggest that the fact that a beneficiary firm of CR Provee had been treated several times during the period analyzed (2004-2011) helps it to increase real wages for its employees (the coefficient associated with D_*dosage* is positive and significant, 0.1659). A possible interpretation of this result is that the more commercial relationships with multinational corporations the SMEs participating in the CR Provee program have (more linkages), the greater the knowledge acquired by those SMEs, producing a positive impact on their future performance.

Taking into account that the comparison group used in the estimations in Table 12 may be improved by using firms whose probabilities of participating in the program are similar to those of firms in the control group, models of Table 12 are estimated again, controlling for fixed effects, but using only the common support firms. These new estimations are considered to be more robust because firms which are not good "clones" of beneficiary firms are eliminated from the control group, based on propensity score matching. Table 13 shows the results of the impact of CR Provee on real wages, using the fixed-effects and propensity score matching approaches.

The results presented in Table 13 are consistent with those shown in Table 12, indicating that participation of SMEs in the CR Provee program certainly has a positive and significant impact on real wages of beneficiary firms (columns 1 to 5). However, we tested if the parallel pretreatment trend assumption was valid and found that using fixed-effect is an invalid approach in this case. In fact, the results for all the coefficients associated with pretreatment variables (PD_) in column 6 are significant and different among them. For this reason, we estimate equation (8)—a PSM with least square dynamic model—according to the discussion in section 3.1.2, the results of which are presented in column 7. The coefficient associated with the treatment variable (D) in this specification is positive and significant (0.0377), so we can conclude that participation of firms in CR Provee has a positive and significant impact on the

real wages. Thus, it can be said that average wages paid by treated firms is 0.038 percent higher in the case of treated firms than untreated firms.

Table 13. Impact of CR Provee Program on Real Average Wages
(Propensity score matching, fixed effects, LS dynamic and cluster-robust standard errors)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variables	PSM+fe	PSM+fe	PSM+fe	PSM+fe	PSM+fe	parallel pretreatment trends test	PSM+least square dynamic
D_t (Dummy equal to one if firm was treated in year t and zero otherwise)	0.0355	0.0619***	0.0641***			0.0409*	0.0377***
	(0.0244)	(0.0210)	(0.0212)			(0.0213)	(0.0146)
D_{t-1} (lagged treatment variable one year)			0.0596***				
			(0.0211)				
D_{t-2} (lagged treatment variable two years)			0.0758***				
			(0.0240)				
Prem * SE (Wage premium due to different labor categories)		0.0313***	0.0317***	0.0327***	0.0326***	0.0314***	0.0115***
		(0.0030)	(0.0030)	(0.0031)	(0.0031)	(0.0030)	(0.0027)
D_*timing*$_t$ (dummy variable equal to one since the first year the firm was treated and so on, and zero otherwise)				0.1909***			
				(0.0278)			
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 zero otherwise)					0.0938***		
					(0.0159)		
PD_1 (pre-treatment dummy equal to one for the first year before the firm was treated and zero otherwise)						-0.0708***	
						(0.0245)	
PD_2 (pre-treatment dummy equal to one for the second year before the firm was treated and zero otherwise)						-0.0642***	
						(0.0206)	
PD_3 (pre-treatment dummy equal to third for the first year before the firm was treated and zero otherwise)						-0.1147***	
						(0.0227)	
(w-p)_t-1 (real wages variable lagged one year)							0.7567***
							(0.0390)
(w-p)_t-2 (real wages variable lagged two years)							0.0451
							(0.0321)
(w-p)_t-3 (real wages variable lagged three years)							0.0883***
							(0.0107)
Constant	13.9604***	13.7796***	13.7754***	13.7647***	13.7664***	13.7801***	1.4811***
	(0.0004)	(0.0171)	(0.0176)	(0.0182)	(0.0180)	(0.0172)	(0.1903)
Observations	12,450	12,450	12,450	12,450	12,450	12,450	12,349
R-squared	0.0003	0.0798	0.0816	0.0883	0.0889	0.0814	0.245
Number of observations	1,626	1,626	1,626	1,626	1,626	1,626	1,620

Note: * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.
Source: Authors' calculations.

Finally, all of the coefficients associated with the pretreatment variables are negative. One possible interpretation of this result is that firms that were facing a bad shock before the treatment were the companies that sought to participate in CR Provee program.

4.2.3 CR Provee's Impact on Labor Demand

The results of the impact of CR Provee on labor demand (number of workers) according to a reduced form of the equation (2) derived in Appendix 2, are presented in Tables 14 and 15. The results of Table 14 refer to estimations using only the fixed-effects method. From column 1 of Table 14 it can be concluded that participation of firms in CR Provee has a positive and significant impact on labor demand in beneficiary firms, given that the coefficient associated with the treatment variable –D_t- is positive and significant (0.1124).

Table 14. Impact of CR Provee Program on Labor Demand
(Fixed effects and cluster-robust standard errors)

	(1)	(2)	(3)	(4)
Variables	**fixed effects**	**fixed effects**	**fixed effects**	**fixed effects**
D_t (Dummy equal to one if firm was treated in year t and zero otherwise)	0.1124***	0.1208***		
	(0.0264)	(0.0256)		
D_{t-1} (lagged treatment variable one year)		0.1429***		
		(0.0269)		
D_{t-2} (lagged treatment variable two years)		0.1398***		
		(0.0316)		
D_*timing*$_t$ (dummy variable equal to one since the first year the firm was treated and so on, and zero otherwise)			0.2693***	
			(0.0347)	
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 zero otherwise)				0.1616***
				(0.0209)
Constant	2.0003***	1.9965***	1.9916***	1.9915***
	(0.0005)	(0.0009)	(0.0014)	(0.0014)
Observations	26,082	26,082	26,082	26,082
R-squared	0.0009	0.0032	0.0054	0.0074
Number of observations	4,628	4,628	4,628	4,628

Note: * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.
Source: Authors' calculations.

The data in column 2 indicate that the impact of participating in CR Provee is obtained during the initial year of the treatment, as well as one and two years after the treatment; the coefficients associated with treatment variables D_t, D_{t-1} and D_{t-2} are positive and significant (0.1208, 0.1429 and 0.1398, respectively). On the other hand, when D_*timing* is replaced by the treatment variable, and the dynamic (non-linear) effects of participation in CR Provee are analyzed (column 3), it may be concluded that the longer the time a firm is treated, the greater the impact on labor demand. The coefficient associated with D_*timing* is positive and significant (0.2693).

Lastly, the results in column 4 on dosage of treatment (D_*dosage*) suggest that the more times a firm is treated in the CR Provee program during the period analyzed (2004-2011), the greater its labor demand. The coefficient associated with D_*dosage* is positive and significant (0.1616).

The results of the impact of CR Provee on labor demand, using only common support firms and controlling for fixed effects, are presented in Table 15. These estimations are considered to be stronger because firms which are not good "clones" of beneficiary firms are eliminated from the control group, based on propensity score matching.

The results in Table 15 confirm the existence of a positive and significant impact of CR Provee on labor demand of beneficiary firms; the coefficient associated with the treatment variable (D_t) is positive and significant (0.0958; column 1). In short, it can be stated that labor demand is 0.096 percent higher in treated firms than in untreated firms. The impact is observed during the same year when the treatment is applied, as well as one and two years later. The values of coefficients associated with treatment variables D_t, D_{t-1} and D_{t-2} are positive and significant (0.0984, 0.1117 and 0.0829, respectively).

When dynamic results of the treatment (D_*timing*) are analyzed, a positive and significant coefficient is obtained (0.2081), indicating that a longer period of treatment has a greater impact on labor demand. In addition, the coefficient associated with dosage (D_*dosage*) is positive and significant (0.1062), indicating that successive treatments have a greater impact on the performance of beneficiary firms than the impact of a single treatment. A possible interpretation of this result is that the more linkages an SME has with a multinational corporation established in Costa Rica, the greater its gains in terms of performance, which may be due to

knowledge transference from the multinational corporation to the SME, as discussed in Section 2 above.

Table 15. Impact of CR Provee Program on Labor Demand
(Propensity score matching, fixed effects and cluster-robust standard errors)

	(1)	(2)	(3)	(4)	(5)
Variables	**PSM+fe**	**PSM+fe**	**PSM+fe**	**PSM+fe**	**parallel pretreatment trends test**
D_t (Dummy equal to one if firm was treated in year t and zero otherwise)	0.0958***	0.0984***			0.0913***
	(0.0305)	(0.0299)			(0.0328)
D_{t-1} (lagged treatment variable one year)		0.1117***			
		(0.0343)			
D_{t-2} (lagged treatment variable two years)		0.0829**			
		(0.0350)			
D_*timing*$_t$ (dummy variable equal to one since the first year the firm was treated and so on, and zero otherwise)			0.2081***		
			(0.0461)		
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 zero otherwise)				0.1062***	
				(0.0217)	
PD_1 (pre-treatment dummy equal to one for the first year before the firm was treated and zero otherwise)					0.0058
					(0.0520)
PD_2 (pre-treatment dummy equal to one for the second year before the firm was treated and zero otherwise)					0.0023
					(0.0381)
PD_3 (pre-treatment dummy equal to third for the first year before the firm was treated and zero otherwise)					-0.0770*
					(0.0409)
Constant	2.3123***	2.3097***	2.3054***	2.3065***	2.3127***
	(0.0005)	(0.0011)	(0.0019)	(0.0015)	(0.0009)
Observations	12,450	12,450	12,450	12,450	12,450
R-squared	0.0009	0.0025	0.0045	0.0052	0.0011
Number of observations	1,626	1,626	1,626	1,626	1,626

Note: * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.
Source: Authors' calculations.

In testing whether the parallel pretreatment trends assumption holds, results from column 5 show that using fixed-effects is a valid approach in this case. In fact, the results for all of the coefficients associated with pretreatment variables are not significant, except for PD_3. However, since the significance of this last coefficient is very low and the first two coefficients of pretreatment variables are not significant, we consider all of this as strong evidence for accepting the parallel pretreatment trends assumption.

4.2.4 CR Provee's Impact on the Probability of Exporting

The results of the impact of CR Provee on the probability of exporting using equation (3) are presented in Tables 16 and 17. Table 16 shows the results of the analysis using a linear probability model with only the fixed-effects approach. The data in the column 1 of Table 16 show that the coefficient associated with the treatment variable (D_t) is positive and significant (0.0315), indicating that participation of SMEs in the CR Provee program increases the probability of exporting for beneficiary firms compared to firms in the control group. In addition, participation in CR Provee seems to have an impact on the export performance of beneficiary firms not only in the year when they receive the treatment, but also two years later. The coefficients associated with these effects are positive and significant (0.0372 and 0.0942, respectively), as shown in column 2 of Table 16.

Table 16. Impact of CR Provee Program on the Probability of Export: Linear Probability Model

(Fixed effects and cluster-robust standard errors)

	(1)	(2)	(3)	(4)
Variables	**fixed effects**	**fixed effects**	**fixed effects**	**fixed effects**
D_t (Dummy equal to one if firm was treated in year t and zero otherwise)	0.0315*	0.0372**		
	(0.0171)	(0.0170)		
D_{t-1} (lagged treatment variable one year)		0.0046		
		(0.0164)		
D_{t-2} (lagged treatment variable two years)		0.0942***		
		(0.0191)		
D_*timing*$_t$ (dummy variable equal to one since the first year the firm was treated and so on, and zero otherwise)			0.0613***	
			(0.0174)	
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 zero otherwise)				0.0585***
				(0.0123)
Constant	0.0981***	0.0969***	0.0962***	0.0948***
	(0.0003)	(0.0005)	(0.0007)	(0.0008)
Observations	26,062	26,062	26,062	26,062
R-squared	0.0005	0.0035	0.0020	0.0068
Number of ncuest	4,625	4,625	4,625	4,625

Note: * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.
Source: Authors' calculations.

Another interesting result of this exercise is that the longer a firm has been treated, the greater the impact on its probability of exporting. The coefficient associated with the dynamic effect of intervention (D_*timing*), shown in the third column of Table 16, is positive and significant (0.0613). In addition, it seems that the more times a firm participates in the CR Provee program, the more its probability of exporting increases. The coefficient associated with the dosage treatment variable (D_*dosage*) is positive and significant (0.0585). In other words, it seems that the greater the number of linkages with multinational corporations created by this program for beneficiary firms, the greater their probabilities of placing their products in international markets.

When the propensity score matching and fixed-effects approaches are used together to estimate the impact of CR Provee on the probability of exporting by beneficiary firms, the results are similar to those obtained when only the fixed-effects approach is used, although these new results are more robust than those shown in Table 16. Thus, as shown in Table 17, all of the coefficients associated with treatment variables (D_t, D_*timing* y D_*dosage*) turn out to be positive and significant in this case (0.0485, 0.0891 and 0.0676, respectively), confirming the importance of SMEs' participation in the CR Provee program for improving their probability of exporting. Thus, the probability of exporting for a treated firm is 4.8 percent higher than for an untreated firm.

Finally, we tested whether the parallel pretreatment trend assumption was valid and found that using fixed-effects is an invalid approach in this case. In fact, the results for all coefficients associated with pretreatment variables (PD_) in column 5 are significant, except for the case of PD_3, where the coefficient is very significant. For this reason, we estimate equation (8)—a PSM with least square dynamic model—according to the discussion in Section 3.1.2, the results of which are presented in column 6. The coefficient associated with the treatment variable (D) in this specification is positive and significant (0.0586), so we can conclude that participation of firms in CR Provee has a positive and significant impact on the probability of exporting. Thus, it can be said that the probability of exporting for a treated firm is 5.9 percentage points higher than that for an untreated firm.

Table 17. Impact of CR Provee Program on Exports: Linear Probability Model
(Propensity score matching, fixed effects, LS dynamic and cluster-robust standard errors)

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	**PSM+fe**	**PSM+fe**	**PSM+fe**	**PSM+fe**	**parallel pretreatment trends test**	**PSM+least square dynamic**
D_t (Dummy equal to one if firm was treated in year t and zero otherwise)	0.0471	0.0485*			0.0428	0.0586**
	(0.0290)	(0.0285)			(0.0295)	(0.0233)
D_{t-1} (lagged treatment variable one year)		-0.0071				
		(0.0271)				
D_{t-2} (lagged treatment variable two years)		0.1111***				
		(0.0263)				
D_*timing*$_t$ (dummy variable equal to one since the first year the firm was treated and so on, and zero otherwise)			0.0891***			
			(0.0291)			
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 zero otherwise)				0.0676***		
				(0.0190)		
PD_1 (pre-treatment dummy equal to one for the first year before the firm was treated and zero otherwise)					0.0138	
					(0.0344)	
PD_2 (pre-treatment dummy equal to one for the second year before the firm was treated and zero otherwise)					0.0039	
					(0.0277)	
PD_3 (pre-treatment dummy equal to third for the first year before the firm was treated and zero otherwise)					-0.0876***	
					(0.0310)	
exp_t-1 (export variable lagged one year)						0.5454***
						(0.0236)
exp_t-2 (export variable lagged two years)						0.2561***
						(0.0299)
exp_t-3 (export variable lagged three years)						0.1158***
						(0.0212)
Constant	0.1166***	0.1154***	0.1138***	0.1127***	0.1170***	0.0172***
	(0.0005)	(0.0009)	(0.0012)	(0.0013)	(0.0006)	(0.0014)
Observations	12,450	12,450	12,450	12,450	12,450	12,450
R-squared	0.0009	0.0048	0.0036	0.0091	0.0023	0.0533
Number of observations	1,626	1,626	1,626	1,626	1,626	1,626

Note: * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.
Source: Authors' calculations.

In general, from all of the preceding discussion, it can be argued that the CR Provee program has a positive impact on real average wages, employment demand, and exports of beneficiary firms. In addition, these benefits are observed beyond the year when the firm first began to participate in the program. It may also be claimed that the time elapsed since a firm first participated in the program, and the treatment dosage it received, are important in determining program impact. These results are encouraging, considering that the operation of the program during the period analyzed suffered from important weaknesses, including its very low budget,[31] a lack of institutional coordination to provide beneficiary firms with other financial and non-financial services, which would have contributed to better performance and greater chances for success. Recent efforts of Costa Rican authorities to provide greater support to beneficiary firms of CR Provee (e.g., helping them to obtain resources from the PROPYME program, thus helping them improve their opportunities for success in their relationships with multinational corporations) may contribute to improving the impact of CR Provee. This idea is reinforced by the result from the following section.

4.2.5 Complementarities or Substitution Effects among Beneficiary Firms of the CR Provee and PROPYME Programs

The data summarized in Table 18 show that very few CR Provee beneficiary firms are also beneficiaries of the PROPYME program—a finding that is consistent with previous findings cited in Monge-González et al. (2010). This leads to the question "How important is it to promote greater use of PROPYME resources by businesses that are seeking to become providers of multinational corporations operating in the country (i.e., beneficiaries of CR Provee)?" This question is especially important because Costa Rican authorities have been working since 2010 on a joint initiative between COMEX and the MICIT to achieve this goal.[32]

[31] According to Procomer, during the last five years its annual budget has accounted for about US$260,000.
[32] Starting in 2010, COMEX established the Linkage Commission with the purpose of strengthening institutional linkages and providing Costa Rican entrepreneurs with more and better tools.

Table 18. Beneficiary Firms of Both the CR Provee and PROPYME Programs
(data from 2003 to 2011)

Year	CR Provee	Propyme	Both
2003	0	0	0
2004	20	7	0
2005	38	11	1
2006	36	3	0
2007	37	12	1
2008	39	17	3
2009	55	14	3
2010	61	17	3
2011	64	22	4

Source: COMEX and MICIT data files.

Equations (4), (5), and (6) are used to estimate the joint impact of the CR Provee and PROPYME programs on beneficiary firms. Table 19 shows results of estimations of equation (4). The first two columns show the results using only the fixed-effects method on the total sample of treated and control firms, while columns 3 and 4 show the results for common support using the Propensity Score Matching (PSM) and fixed effects approaches jointly. The latter results are considered to be more robust because they not only control for non-observable variables (fixed effects) but also for observable attributes which are controlled for through the PSM method. Additionally, columns 5 and 6 show the results for the parallel pretreatment trends test and the estimation of PSM with least squared dynamic model.

Table 19. Joint Impact of CR Provee and PROPYME on Real Average Wages

(Propensity score matching, fixed effects, LS dynamic and cluster-robust standard errors)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	**fixed effects**	**fixed effects**	**PSM+fe**	**PSM+fe**	**parallel pretreatment trends test**	**PSM+least square dynamic**
CRP_{it} (Dummy equal to one if firm *i* was treated by CR Provee in year *t* and zero otherwise)	0.1212***	0.1223***	0.0619***	0.0617***	0.0403*	0.0488***
	(0.0157)	(0.0154)	(0.0210)	(0.0210)	(0.0213)	(0.0169)
Prem * SE (Wage premium due to different labor categories)	0.0775***	0.0775***	0.0313***	0.0313***	0.0315***	0.0448***
	(0.0052)	(0.0052)	(0.0030)	(0.0030)	(0.0030)	(0.0035)
$CRP\&PRP_{it}$ (Dummy equal to one if firm *i* was treated by both CR Provee and Propyme programs in year *t* and zero otherwise)		0.2611***		0.1285***	0.1447**	0.1320***
		(0.0749)		(0.0447)	(0.0572)	(0.0458)
PD_1 (pre-treatment dummy equal to one for the first year before the firm was treated and zero otherwise)					-0.0713***	
					(0.0244)	
PD_2 (pre-treatment dummy equal to one for the second year before the firm was treated and zero otherwise)					-0.0656***	
					(0.0205)	
PD_3 (pre-treatment dummy equal to third for the first year before the firm was treated and zero otherwise)					-0.1162***	
					(0.0226)	
(w-p)_t-1 (real wages variable lagged one year)						0.0544***
						(0.0102)
(w-p)_t-2 (real wages variable lagged two years)						0.0455***
						(0.0099)
(w-p)_t-3 (real wages variable lagged three years)						0.0740***
						(0.0093)
Constant	13.4258***	13.4253***	13.7796***	13.7794***	13.7799***	13.3069***
	(0.0263)	(0.0264)	(0.0171)	(0.0172)	(0.0172)	(0.0307)
Observations	26,082	26,082	12,450	12,450	12,450	12,349
R-squared	0.1627	0.1631	0.0798	0.0800	0.0816	0.1297
Number of observations	4,628	4,628	1,626	1,626	1,626	1,620

Note: * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.
Source: Authors' calculations.

In general, a significant and positive coefficient is obtained in column 6 associated with the CRP&PRP variable (0.1320), which indicates the existence of a positive impact of the joint support of the CR Provee and PROPYME programs on real wages of beneficiary firms. While the coefficient associated with the CRP variable (0.0488), which is positive and significant, indicates that those firms that are beneficiaries only of CR Provee have an average wage per employee 0.048 percent greater than the average wage of firms in the control group (non-beneficiaries), the impact more than doubles when CR Provee beneficiary firms also receive support from the PROPYME program (0.1320 versus 0.0488). In addition, the coefficient associated with the CRP&PRP variable indicates that firms which simultaneously benefit from CR Provee and PROPYME are able to pay salaries that are 0.132 percent higher than those of non-beneficiary firms. This last result is the most robust, since according to the parallel pretreatment test we must use a PSM with least squared dynamic model instead of one PSM with fixed effects. (See results for coefficients of PD variables in column 6. All are significant.)

The results for the joint impact of CR Provee and PROPYME on labor demand, based on the estimation of equation (5) of Section 3.1.2, do not show a positive and significant impact of such a joint intervention, either when measured through the fixed-effects method or through the fixed-effects plus PSM methods. As shown in columns 1 and 4 of Table 20, although the coefficient associated with the CRP&PRP variable is positive, it is not significant. According to the results of the parallel pretreatment trends test, the fixed-effects approach is valid (see column 5).

Table 20. Joint Impact of CR Provee and PROPYME on Labor Demand
(Propensity score matching, fixed effects and cluster robust standard errors)

	(1)	(2)	(3)	(4)	(5)
VARIABLES	**fixed effects**	**fixed effects**	**PSM+fe**	**PSM+fe**	**parallel pretreatment trend test**
CRP_{it} (Dummy equal to one if firm *i* was treated by CR Provee in year *t* and zero otherwise)	0.1124***	0.1134***	0.0958***		0.0907***
	(0.0264)	(0.0264)	(0.0305)		(0.0327)
$CRP\&PRP_{it}$ (Dummy equal to one if firm *i* was treated by both CR Provee and Propyme programs in year *t* and zero otherwise)		0.2317*		0.1552	0.1567
		(0.1303)		(0.1923)	(0.1877)
PD_1 (pre-treatment dummy equal to one for the first year before the firm was treated and zero otherwise)					0.0053
					(0.0519)
PD_2 (pre-treatment dummy equal to one for the second year before the firm was treated and zero otherwise)					0.0008
					(0.0375)
PD_3 (pre-treatment dummy equal to third for the first year before the firm was treated and zero otherwise)					-0.0786*
					(0.0405)
Constant	2.0003***	2.0000***	2.3123***	2.3138***	2.3126***
	(0.0005)	(0.0005)	(0.0005)	(0.0001)	(0.0009)
Observations	26,082	26,082	12,450	12,450	12,450
R-squared	0.0009	0.0011	0.0009	0.0001	0.0012
Number of observations	4,628	4,628	1,626	1,626	1,626

Note: * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.
Source: Authors' calculations.

Finally, to estimate whether the joint support of CR Provee and PROPYME had an effect on the exporting probability of beneficiary firms, equation (6) discussed in section 3.1.2 was estimated using a linear probability model. The results of this exercise are presented in Table 21, from which it may be concluded that firms that are beneficiaries only of CR Provee show an increase in their probability of exporting because the coefficient associated with variable CRP is positive and significant (0.0596) (column 5). These results indicate that the probability that CR Provee beneficiary firms will export is 5.9 percentage points higher than that of non-beneficiary

firms. In addition, being simultaneously a beneficiary of both CR Provee and PROPYME does not increase a firm's exporting probability; the coefficient associated with the CRP&PRP variable, although positive, is not significant (0.0131), indicating that the probability of exporting by firms that are beneficiaries simultaneously of CR Provee and PROPYME is the same as that of non-beneficiary firms.

Table 21. Joint Impact of CR Provee and PROPYME on the Probability of Exporting: Linear Probability Model

(Propensity score matching, fixed effects, LS dynamic and cluster-robust standard errors)

	(1)	(2)	(3)	(4)	(5)
VARIABLES	**fixed effects**	**fixed effects**	**PSM+fe**	**PSM+fe**	**PSM+least square dynamic**
CRP_{it} (Dummy equal to one if firm *i* was treated by CR Provee in year *t* and zero otherwise)	0.0315*	0.0321*	0.0471	0.0469	0.0596**
	(0.0171)	(0.0172)	(0.0290)	(0.0291)	(0.0232)
$CRP\&PRP_{it}$ (Dummy equal to one if firm *i* was treated by both CR Provee and Propyme programs in year *t* and zero otherwise)		0.1356**		0.1326	0.0131
		(0.0609)		(0.1320)	(0.0337)
exp_t-1 (export variable lagged one year)					0.5792***
					(0.0217)
exp_t-2 (export variable lagged two years)					0.3204***
					(0.0232)
Constant	0.0981***	0.0979***	0.1166***	0.1165***	0.0183***
	(0.0003)	(0.0003)	(0.0005)	(0.0005)	(0.0015)
Observations	26,062	26,062	12,450	12,450	12,450
R-squared	0.0005	0.0010	0.0009	0.0012	0.0013
Number of observations	4,625	4,625	1,626	1,626	1,626

Note: * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.
Source: Authors' calculations.

5. Conclusions and Policy Recommendations

This study has attempted to estimate the impact of two important productive development programs (PDPs) in Costa Rica: PROPYME and CR Provee. Impacts have been estimated assuming that beneficiary firms are trying to maximize their profits and that both PDPs aim to increase these firms' productivity. The impact of the two programs 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 pretreatment trends was done as a robustness check for using 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 0.19 percent higher than among untreated firms. The exporting probability of treated firms was found to be about 9.6 percentage points higher than 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). Likewise, 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.

The CR Provee program was also found to have positive and significant impacts on the performance of beneficiary firms, specifically on their real average wages, labor demand, and probability of exporting. Average wages paid by firms treated by CR Provee were found to be about 0.04 percent higher than those paid by untreated firms, and labor demand was found to be about 0.10 percent higher than that of untreated firms. Such benefits were observed up to two years beyond the initial year when the firm participated in the program. The amount of time elapsed since the first participation in CR Provee, as well as the number of times that SMEs were able to generate linkages with multinational corporations, also had a positive impact on the performance of beneficiary firms. The probability of exporting for a treated firm was found to be about 5.9 percentage points higher than for untreated firms.

With respect to complementarities between CR Provee and PROPYME, firms treated simultaneously by both programs experienced greater improvement in their performance than

those treated by CR Provee only. Thus, firms that are simultaneous beneficiaries of both the CR Provee and the PROPYME programs are able to pay average wages to their employees that are about 0.13 percent higher than the average wages paid by non-beneficiary firms. However, a joint impact of CR Provee and PROPYME either on labor demand or on the probability of exporting was not found. This result may be of particular interest to policy makers because it indicates the importance of bundling in the implementation of PDPs.

These results are encouraging, considering that the PROPYME and CR Provee programs during the period analyzed suffered from significant weaknesses. In the case of PROPYME, these included a lack of flexibility in selecting a partner with which to execute the project and the ability to enter into the program throughout the year, while in the case of CR Provee they included a very low budget 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 of both programs may contribute to maintaining and increasing the impact of the PROPYME and CR Provee programs in the future. In short, the findings suggest that policies aimed at overcoming the weaknesses of these two programs are important to obtain higher real wages and generate more employment opportunities and exports by Costa Rican SMEs.

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Appendix 1. Estimating the Impact of Participation in a Program on Real Wages

Let us assume that the production function is a modified Cobb-Douglas

$$Y = K^{\alpha} L^{1-\alpha} \exp(\delta D + \varepsilon) \quad (1)$$

where *Y* is output, *K* capital, *L* the number of workers, and *D* a dummy variable equal to 1 if the firm participated in the program and 0 otherwise. The coefficient on this dummy variable allows us to test if the participation in an innovation or a linkage development program—such as PROPYME and CR Provee—affects total factor productivity.

Under a profit maximization assumption, the FOC tells us that

$$PK^{\alpha}(1-\alpha)L^{-\alpha} \exp(\delta D + \varepsilon) - W = 0 \quad (2)$$

where *P* is the price of the output produced by the firm.

Taking logs and arranging terms

$$w - p = ln(1-\alpha) + \alpha(k-l) + \delta D + \varepsilon \quad (3)$$

Thus, real wages depend on $(k-l)$ and total factor productivity $(\delta D + \varepsilon)$

On the other hand, if we add a mix of workers with different qualities we get

$$L^{*} = L_1 + \theta_2 L_2 + \cdots = L(1+q) \quad (4)$$

But it is likely that labor input is the result of the services provided by workers of different qualities. Let us replace *L* with "effective labor" L^{*}. Then equation (2) can be expressed as follows,

$$PK^{\alpha}(1-\alpha)(L)^{-\alpha}(1+q)^{1-\alpha} \exp(\delta D + \varepsilon) - W = 0 \quad (5)$$

taking logs

$$w - p = ln(1-\alpha) + \alpha(k-l) - (1-\alpha)\, ln(1+q) + \delta D + \varepsilon \quad (6)$$

Supposing that we have only two types of workers—skilled and unskilled—we have a difference in productivity θ and a "premium" PREM, so that $\theta - 1 = PREM$.

Let *WO* and *WE* be the average wages of unskilled and skilled workers, and *LO* and *LE* the number of unskilled and skilled workers, respectively.

The average wage of the firm can be written as

$$W = (WO * LO + WE * LE)/(LO + LE) \quad (7)$$

This expression is equal to

$$W = WO * (1 - LE/(LO + LE)) + WE * (LE/(LO + LE))$$

$$= WO * \left(1 + (WE/WO - 1)(LE/(LO + LE)\right) \quad (8)$$

Let $PREM = (WE/WO - 1)$ be the skilled workers premium.

Additionally, define $(LE/(LO + LE))$ as the share of skilled workers and use *SE* as the abbreviation for this term (i.e., $SE = (LE/(LO + LE))$.

Taking logs on (7) and substituting terms we get

$$lnW \approx lnWO + (PREM * SE) \quad (9)$$

The principal idea here is that the average wage of the firm is equal to the wage of unskilled workers plus a term that takes into account the premium charge by skilled workers times the share of this type of worker in the total number of workers.

Let $L^* = LO + \theta * LE$

$$= L(LO/L + \theta\, LE/L)$$

where $L = LO + LE$

Given that $LO/L = 1 - LE/L$, then

$$L^* = L(1 + (\theta - 1)SE) \quad (10)$$

taking logs

$$l^* = (\theta - 1)SE \quad (11)$$

Therefore, from (4) we know that $(\theta - 1)SE = q$

From the discussion above we know that under profit maximization behavior of the firm we also have a "premium" called PREM = $\theta - 1$

$$q = (\theta - 1)SE = PREM * SE \quad (12)$$

That means that differences in productivity are equal to the premium in wages.

Substituting (12) for (6) we have

$$w - p = ln(1 - \alpha) + \alpha(k - l) - (1 - \alpha)\ (PREM * SE) + \delta D + \varepsilon \quad (13)$$

To operationalize (13) we can write

$$w - p = \beta_0 + \beta_1(k - l) + \beta_2\ (PREM * SE) + \beta_3 D + \tau \quad (14)$$

As discussed in the body of this paper, equation (14) can be estimated using a combination of two techniques: fixed effects and propensity score matching (PSM). Due to problems with data availability for capital (*k*), we assume that fixed effects lets us control the effect of $(k - l)$. Although we are assuming that the effect of the program occurs in the same year as the intervention, we will test if that is actually the case or we have to wait one or two

years after the firm received the treatment to see any effect. This is the reason for including lags for variable *D*.

For purposes of estimation, equation (14) can be expressed as follows:

$$(w-p)_{it} = \beta_0 + \beta_1 (PREM * SE)_{it} + \beta_2 D_{it} + \beta_3 D_{it-1} + \beta_4 D_{it-2} + \varepsilon_{it} \quad (15)$$

Finally, given data availability constraints, we use as a proxy for "$PREM * SE$" the ratio between the firm's average wages and the industry's average wages for each year included in the analysis, all of them in nominal values.

Appendix 2. Estimating the Impact of Participation in a Program on Labor Demand

Let us assume that the production function is a modified Cobb-Douglas function

$$Y = K^{\alpha} L^{1-\alpha} \exp(\delta D + \varepsilon) \quad (1)$$

where *Y* is output, *K* capital, *L* the number of workers, and *D* a dummy variable equal to 1 if the firm participated in the program and 0 otherwise. In this formulation, participation in an innovation or a linkage development program—such as PROPYME and CR Provee—might affect total factor productivity.

From the first order conditions of profit maximization and taking logs, we have

$$p + \alpha k + ln(1-\alpha) - \alpha l + \delta D + \varepsilon - w = 0 \quad (2)$$

where p is the price of the output produced by the firm (in logs).

Arranging terms, we have

$$l = \frac{p}{\alpha} + \frac{\alpha k}{\alpha} + \frac{ln(1-\alpha)}{\alpha} + \frac{\delta D + \varepsilon}{\alpha} + \frac{w}{\alpha}$$

$$l = \frac{1}{\alpha} p + k + \frac{1}{\alpha} ln(1-\alpha) + \frac{1}{\alpha}(\delta D + \varepsilon) - \frac{1}{\alpha} w$$

$$l = \tfrac{1}{\alpha} ln(1-\alpha) + k - \tfrac{1}{\alpha}(w-p) + \tfrac{1}{\alpha}(\delta D + \varepsilon) \quad (3)$$

As discussed in the main body of this paper, equation (3) can be estimated using a combination of two techniques: propensity score matching (PSM) and fixed effects. Due to problems with data availability for capital (*k*), we assume that fixed effects lets us control the effect of this variable. Once again, we are assuming that the effect of the program occurs in the same year as the intervention, but also test to determine if this is actually the case or if we have to wait one or two years after the firm received the treatment to see any effect. This is the reason for including lags for variable *D*. Thus, equation (3) can be expressed as follows:

$$l_{it} = \gamma_0 - \gamma_1 (w-p)_{it} + \gamma_2 D_{it} + \gamma_3 D_{it-1} + \gamma_4 D_{it-2} + \sigma_{it} \quad (5)$$

Appendix 3. Variable Definitions (in alphabetical order)

Chemicals: Dummy variable which takes the value 1 if the firm has economic activity in chemicals and 0 otherwise.

Employment: Number of employees hired by the firm per year.

Exports (t): Dummy variable which takes the value 1 if the firm has exported during the year *t,* and 0 otherwise.

Geographic location**:** Dummy variable which takes the value 1 if the firm is located in province *i* of Costa Rica, and 0 otherwise. We consider six of the seven provinces from Costa Rica (San José, Alajuela, Cartago, Heredia, Guanacaste, and Puntarenas).

Legal status: Dummy variable which takes the value 1 if the firm is legally registered as a commercial legal entity and 0 otherwise.

Lithographic: Dummy variable which takes the value 1 if the firm engaged in lithographic processes and 0 otherwise.

Manufacturing: Dummy variable which takes the value 1 if the firm engaged in manufacturing and 0 otherwise.

Wages or salaries in real terms**:** Total amount of salaries paid by the firm per year. This amount has been deflated by the industrial price index at the 2-digit level of the SIC in the case of manufacturing firms, and otherwise by the consumer price index, to obtain real wages.