Supplier development programs and firm performance: evidence from Chile
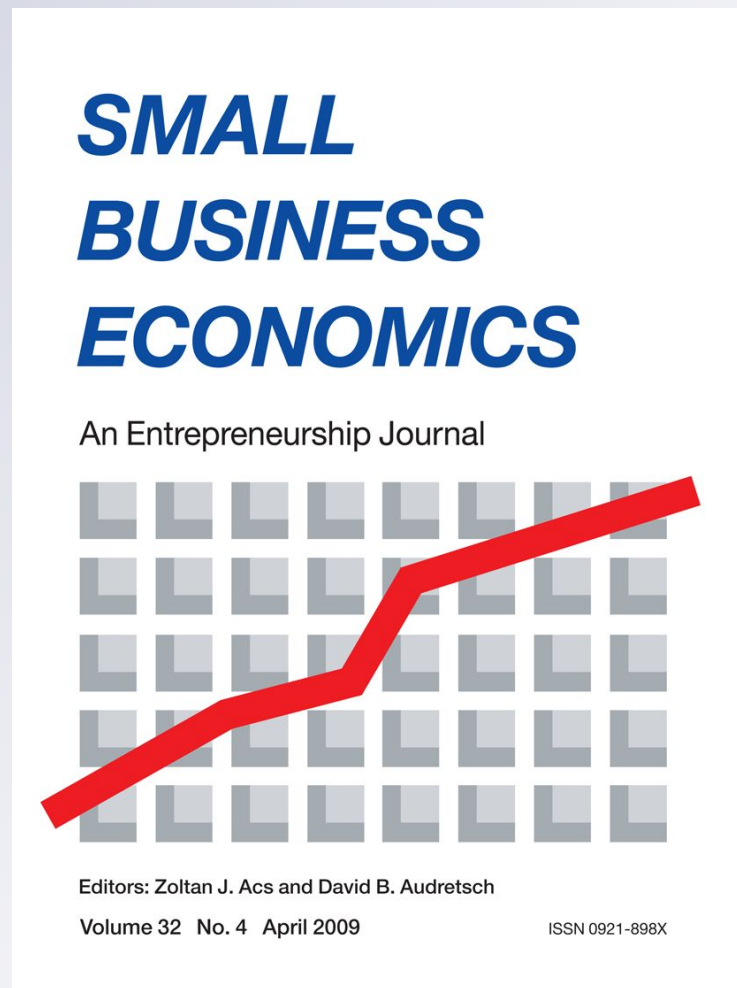
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Supplier development programs and firm performance: evidence from Chile

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Abstract This paper evaluates the impact of the Chilean Supplier Development Program, aimed at improving and stabilizing the commercial linkages between small and medium-sized suppliers and their large firm customers, during the period 2003–2008. We use the panel structure of our dataset to control for observables and time-invariant unobservable factors that affect the participation and performance of firms. We find that both small and medium enterprises and large firms benefited from the coordination efforts. The program increased sales, employment, and the sustainability of small and medium-sized suppliers; it also increased the sales of large firms and raised their ability to become exporters. In addition, we find that the timing of the effect is different for suppliers and large firms. While the effect on suppliers appeared 1 year after the firms enrolled in the program, the effect on large firms took 2 years to appear.

1 Introduction

Chile is one of Latin America's most successful countries in the area of economic development and growth, and an important leverage of this success has been the exploitation of new export opportunities. The trade agreements signed by Chile since the 1990s enabled new industries to emerge and spurred the creation of the Supplier Development Program (*Programa de Desarrollo de Proveedores, PDP*). This program aims to promote mutually beneficial, long-term commercial relationships between large buying firms—potential exporters—and their small and medium enterprise (SME) suppliers to increase competitiveness.

National competitiveness, although an elusive concept, depends on creating a business environment that encourages firms to productively use inputs—labor, natural resources, technology, and financial

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capital. This appropriate business environment implies, in some cases, a minimalist role for government and in some other cases an active role. Determining in which areas government must pursue an active role is, however, the subject of debate among policy-makers. What is clear is that, by choosing policies, laws, and institutions that limit competition, governments can stunt innovation, slow productivity improvements, and, consequently, harm the competitiveness of their countries' firms in the long run.

According to Porter (1990), a nation's competitive advantage in a particular industry is at least partly determined by the presence of a network of suppliers, buyers, competitors, and related industries—those that share activities in the value chain—that are themselves competitive and that can help the firms' industry gain competitive advantages in the sale of their products and services. Likewise, a firm's competitive advantage does not only rest within its capabilities but depends on the linkages it forges with its suppliers and their ability to achieve end-consumer satisfaction. The quantity and quality of local suppliers and the extent of their interaction can lead to the emergence of clusters that heighten efficiency, create opportunities for innovation, and reduce barriers to entry for new firms in the industry.

The presence of a high-quality network of local suppliers might help explain why some countries' industries are competitive (Porter 1990).[1] But there is no guarantee that attracting a competitive industry to invest in a particular country in response to tax incentives, low labor costs, or other inducements will lead to the development of an efficient, competitive network of local suppliers. The case of Mexico is illustrative. After trade liberalization and adherence to the North American Free Trade Agreement (NAFTA), Mexico received a massive inflow of foreign direct investment (FDI) looking to take advantage of low labor costs and unrestricted market access to the United States. This inflow led to a dynamic expansion of exports that has been decoupled from gross domestic product (GDP) growth due to the FDI's remarkably weak production linkages with the rest of the economy. According to Palma (2005), at their peak (in 2002), domestic inputs accounted for just 3.7 % of total inputs in the *maquila* manufacturing sector. The

situation in the non-*maquila* manufacturing sector was not very different and was reflected in the collapse of the export multiplier. As the case of Mexico shows, local suppliers compete against overseas suppliers, and their potential clients ultimately buy from the most competitive vendors on a worldwide basis.

The elimination of barriers to international trade has opened markets and created opportunities for industries to emerge in places where they would not otherwise have been able to.[2] The development benefits of trade liberalization policies, however, do not come about automatically. Linkages and spillovers need to expand from the newly established competitive industries, most via FDI, to the rest of the economy if the country is to maximize the benefits of trade liberalization. There is evidence that developing a network of local suppliers is the surest way to achieve those benefits.[3] There is also evidence suggesting that the magnitude of the linkages depends on the capabilities of domestic firms and their absorptive capacities.[4] This suggests that governments should work to create an environment where networks of local suppliers are able to develop those capabilities, comply with international production standards, and meet the requirements of international firms.

This has been the approach followed by the Chilean government through CORFO, its economic development agency. Instead of relying on firms' willingness to carry out a supplier development strategy of their own, CORFO created an institutionalized Suppliers Development Program. Traditionally, the commercial relationship between a buying firm and its suppliers has been perceived as short-term, unstable, and adversarial. In most cases, buying firms have no incentive to invest in developing long-term supplier capabilities because they cannot exclusively

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[1] This argument is also raised by Malmberg and Maskell (1997, 2006).

[2] Using plant-level panel data on Chilean manufacturers, Pavcnik (2002) finds evidence of within-plant productivity improvements in the import-competition sector that can be attributed to liberalized trade. She also finds that, in many cases, aggregate productivity improvements stem from the reshuffling of resources and output from less to more efficient producers.

[3] Alfaro and Rodriguez-Clare (2004) indicate that many studies fail to find evidence of positive externalities from multinationals to local firms in the same sector (horizontal externalities), but confirm the existence of positive externalities in upstream industries (vertical externalities).

[4] Girma and Görg (2005) and Görg and Greenaway (2004) show that absorptive capacity matters for productivity spillover benefits.

appropriate the benefits of any improvement. Likewise, suppliers rarely have an incentive to invest in developing these capabilities, because there is no guarantee that they can profit in the long run from the costly changes required.

The Suppliers Development Program aims at improving and stabilizing the commercial linkages between small and medium-sized local suppliers and their large firm customers—potential exporters—in order to achieve higher levels of flexibility and adaptability and to guarantee the quality of products and services at different stages of production. The justification for the intervention via public subsidies is that not only does the program benefit large firms, through offering them higher-quality inputs at lower prices, but it strengthens the management of local suppliers and improves their capabilities, which in turn leads to more competition in downstream markets and increases domestic productivity, production, and employment.[5] The ultimate goal of this long-term cooperative effort is to form a mutually beneficial relationship to help buying firms and their suppliers compete more effectively in the marketplace. The hypotheses tested in this paper are precisely the assumptions and justifications on which the program rests, namely that the cooperative effort is beneficial for suppliers and buyers and that improved supplier capability ultimately increases domestic productivity, production, and employment.

We use data from the administrative records of the program as well as accounting information from *Servicios de Impuestos Internos* (SII), the Chilean tax administration agency. By matching these data sources, we construct a firm's panel data with the entire population of tax-compliant Chilean firms. Therefore, we are able to identify the program beneficiaries and construct a pool of potential control firms.

Moreover, this dataset allows us to identify the moments at which the firms start and finish the program and provides us with information about the firms before and after they participate in the program. This information allow us to identify the causal effect

of the program by controlling for observables and time-invariant unobservable factors that may affect the participation in the program and firms' performance.

We find that both groups of firms benefit from the program's coordination efforts. Suppliers increase their sales, employ more workers, and pay higher salaries, while also boosting their sustainability or survival capabilities (measured by a dummy that indicates if the firms report positive sales). Large firm customers increase their sales and their capacity to export products and services. However, we do not find evidence showing that the program affected large firms' employment, salaries, or survival.

The main contribution of the paper is to provide evidence about the effectiveness of the Supplier Development Program on both supplier and sponsor firms. In addition, to the best of our knowledge, this paper is the first evaluation of a supplier development program promoted at a country level and aimed at benefiting both buying firms (regardless of the investment's country of origin) and their suppliers.[6] Therefore, with all the caveats about the external validity of impact evaluations, the results in this paper shed light on the impact that these types of programs might have on firms' performance. These findings are particularly important because the Chilean Supplier Development Program was the basis for the design of supplier development programs in Colombia, Mexico, and Uruguay.

The remainder of the paper is organized as follows. Section 2 discusses government policies aimed at creating backward linkages. Section 3 describes the Suppliers Development Program implemented in Chile. Section 4 describes the data used in the paper, compares the characteristics of firms that participated in the program with those that did not, presents the

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[5] Through subsidies, CORFO creates incentives for large firms to provide training, professional advice, technical assistance, and transfer of technology to SME suppliers at a lower cost. This behavior signals to SME suppliers its client's commitment to developing a long-term relationship with them.

[6] Most of the related existing literature analyzes either the effect of a particular firm—usually a multinational corporation—on local suppliers in the sector of operation, or the effect of FDI on productivity in related domestic industries at the national level. Although in these cases firms could have consciously developed linkages with their local suppliers, the analysis of the role of government' programs in the promotion of these linkages is rare (Lauridsen 2004). The World Bank evaluated the impact of SME support programs in Chile—nine CORFO matching grants and credit programs which included the PDP—but the percentage of firms that benefited from the PDP accounted for only 2 % of beneficiary firms in the sample analyzed (López-Acevedo and Tan 2010).

empirical approach used, and discusses the results. Section 5 concludes with a discussion of the program's implications.

2 Policies to promote backward linkages

The creation of backward linkages between large firms and the local SME sector is affected by the business environment and government policies that facilitate enterprise development: political and macroeconomic stability, rule of law, institutional framework, infrastructure, labor force, and so on. However, the most important factors shaping these linkages are the capabilities and absorptive capacities of local SMEs and their ability to compete on quality and cost. Large buyer firms often complain that local SMEs usually lack the information, the experience, the human and financial resources, and the "right attitude" to implement the management and technology changes required to do business with them.

Below are some policies that governments have formulated to directly address these issues and promote backward linkages:

(i) *Gathering and disseminating information on linkage opportunities*. Either directly or by supporting private institutions, governments promote the creation of information exchanges that offer lists of inputs and materials available locally (perhaps including prices and qualities), names, locations, and profiles of local suppliers, and other data. By doing that, governments reduce the search cost of large buyer firms who are either unaware of potential local suppliers or find it too costly to locate them.

(ii) *Matchmaking*. Governments take a more active role in working out arrangements between suppliers and buyers, either by working one on one with them or by organizing fairs, missions, and conferences to bring together suppliers and buyers in specific industries. Governments also act as brokers if problems arise after the linkages are established.

(iii) *Providing economic incentives in the form of tax exemptions and subsidies to promote training and technology transfer from buyer firms to local supplier firms*. By exempting exporters from value added tax, governments encourage the use of local inputs; by treating costs incurred in the creation of linkages as tax-deductible expenses from corporate income tax, governments promote their creation.[7] The Suppliers Development Program in Chile falls into this category. By subsidizing the cost associated with the activities promoted by the program—improvement in management, professional advice, training of personnel, technical assistance, and technology transfer—the government encourages SMEs already in business with their large firm buyers to take steps to increase their competitiveness and improve and stabilize the already-established commercial linkages. By reducing the cost for SMEs—but not eliminating it completely—the program guarantees that these firms exhibit the "right attitude," signaling their commitment to upgrade quality and make continuous improvements.

The encouragement of information exchange discussed in points (i) and (ii) presupposes that suitable local suppliers exist and that the problem faced by large firm buyers is limited to high search and match costs. These policies, by themselves, cannot address domestic suppliers weaknesses that, as pointed out previously, are the main deterrents to the establishment of linkages. Policies discussed in point (iii) create incentives to address these weaknesses. Until recently (depending on the trade agreements in place), countries used high tariffs, rules of origin, domestic-content requirements, and market reservations to pressure foreign firms to increase their use of national inputs and domestic value added. These types of import-substitution policies have been discontinued in the context of the World Trade Organization (WTO) and other international agreements and because they might deter rather than attract FDI.

Some Asian countries—for instance, Malaysia, Thailand, and Singapore—created national vendor development programs in the 1990s that encouraged multinationals and large local firms to provide technical assistance and procurement contracts to local SMEs. In some cases, the local SMEs were then eligible for subsidized finance (Doner and Ritchie

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[7] These costs are associated with training, product development, testing, and factory audit to ensure the capabilities of potential local suppliers and the quality of their products.

2003). The programs had mixed results. Studies by Abu Bakar (2003) indicate that about 73 % of the Malaysian SMEs that participated were unsuccessful in achieving the program's objectives. Doner and Ritchie (2003) state that the government efforts at vendor development in Thailand were ineffective.

For policies aimed at promoting backward linkages to be successful, an appropriate business environment is essential. The Organization for Economic Co-operation and Development (OECD 2008) states in its *Review of Agricultural Policies* in Chile that the factors that explain "what has prompted the discovery of new export opportunities … include trade liberalization, the attainment of relative macroeconomic and political stability, the encouragement of FDI, extended periods of exchange rate depreciation, and supportive government policies." Agosin and Bravo-Ortega (2009) indicate that the role of the Chilean government in the emergence of new, non-traditional exports has been modest: "there is little evidence of a deliberate policy to promote particular sectors or even new exports in general. In fact, the official stance of policy makers has been one of complete neutrality.[8]"

3 Chile's Supplier Development Program (PDP)

Launched by CORFO in 1998[9], the Supplier Development Program was motivated by trade agreements signed by Chile that forced Chilean exporters and potential exporters to comply with international production standards. The program was designed to strengthen commercial linkages between small and medium-sized suppliers and their large firm customers—potential exporters—so as to achieve higher levels of flexibility and adaptability and to guarantee the quality of products and services at different stages of production.

The government program subsidizes projects aimed at strengthening the management of SMEs that supply large firms, which in turn sponsor the projects. The program also subsidizes activities that complement the sponsor firms' projects: specialized services, professional advice, training, technical assistance, and technology transfer. SMEs benefit from the creation of a stable market for their products and services, while sponsor firms benefit from the creation of a continuous supply of quality products and services.

For a large firm to be eligible to sponsor the SMEs that make up its supply chain, the firm's net annual sales must be at least 100,000 *Unidades de Fomento*—equivalent to \$42.6 million in August 2010.[10] Each project must include at least 20 SMEs in the agriculture and forestry sector or a minimum of 10 SMEs in other economic activity sectors such as manufacturing, industrial services, and others; these SMEs must not have net annual sales over 100,000 UF. Once the sponsor firm approaches an intermediary agent, who helps the sponsor firm prepare the project, the firm can present its project to a CORFO regional bureau that will decide to reject it, approve it, or request its reformulation according to the eligibility requirements and the technical quality of the application. After the project is approved, the program is implemented in two stages: a diagnostic stage and a development stage. The diagnostic stage lasts up to 6 months after the signing of the contract and aims to identify areas of intervention that the sponsor wishes to develop with its suppliers. Once these areas are identified, a development plan is designed by a consultant or consulting firm. CORFO pays for up to 50 % of the cost of the plan's design, with a ceiling of \$16,000 (August 2010). In the development stage, which can last up to 3 years, the development plan is implemented by the sponsor firm's staff or by a consulting firm. CORFO also pays for up to 50 % of the cost of this stage, with annual ceilings of \$110,000, or \$5,000 per supplier firm (August 2010). CORFO assesses the progress of implementation annually and renews or terminates the project's financing accordingly.

A project subsidized by the program, then, must be sponsored by a large firm and include a minimum number of SMEs that constitute this firm's supply chain. The project cofinances a diagnostic stage to assess the suppliers' needs, and then a development plan is designed and implemented to benefit all parties.

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[8] The *2010–2020 Innovation and Competitiveness Agenda* created by the National Innovation Council for Competitiveness shows a renewed interest in government policies aimed at concentrating efforts in selected sectors.

[9] CORFO is the Chilean Economic Development Agency.

[10] The *Unidad de Fomento* (UF) is a unit of account widely used in Chile that reflects the real value of the Chilean peso. The UF is adjusted to inflation to keep its real value constant.

The Chilean Suppliers Development Program served as the basis for the creation of a similar programs in Colombia, El Salvador, Mexico, and Uruguay.

4 Evaluating the impact of the PDP

CORFO allowed full access to the PDP's electronic and physical records. From 2005 on, we were able to identify information on projects, including information on the sponsor and supplier firm beneficiaries of each project. We were also able to identify the firms' participation in the diagnostic and development stages as well as the exact date of the diagnostic stage for projects that started in 2005 or later—that is, for 80.3 % of the sample. Firms that participated in the program and completed their projects in 2004 or earlier were not identified.[11,12] We were able to identify projects that started before 2005 but that were still in execution during that year (19.7 % of the sample started their participation between 2003 and 2004). In total, we identified 439 projects, together with their sponsors (271 firms) and suppliers (8,828 firms). These projects were in execution between 2003 and 2008. Most of the supplier firms, 79 %, were in the agribusiness sector; the highest concentrations were located in the regions of Maule and Bío Bío. Meanwhile, only 56.9 % of sponsor firms were classified as agribusinesses, most of them in Santiago's metropolitan area.

In order to measure the impact of the PDP on sponsor and supplier firm' performance, we used secondary data from SII.[13] SII's Department of Economic and Tax Studies merged data on the PDP's beneficiaries to SII's dataset for the years 1998−2008,

which allowed us to construct a treated and control group to evaluate the program.[14] The dataset result of the merge is an unbalanced panel of firms that includes all the firms paying taxes in Chile, which allowed us to have information on beneficiaries and non-beneficiaries several years before and after they were part of the program. The frequency of the data used was annual.

The merged dataset (SII and CORFO) included 101 sponsor and 3,863 supplier firms that had completed the program by 2008. Firms that started the diagnostic stage in or after 2006 and that were in the process of completing the treatment in 2008 were not included in the analysis, which reduced the sample size (see Table 1). We restricted our attention to supplier firms in the agribusiness sector, since they made frequent use of the program and its interventions. Although different for each project, they tend to be similar in nature—this sector represents close to 80 % of the universe of treated firms, before merging the PDP's beneficiaries to SII's dataset and 87 % after restricting the sample to those firms that completed their projects by 2008. We did not impose restrictions regarding sponsor firms.

4.1 Empirical strategy

It is possible that small and medium-sized suppliers and their large firm customers could benefit from the program; moreover, the effect of the program could also vary across firm types. With this in mind, it is helpful to analyze the impact of the program on both groups of firms separately.

As explained above, the program was not randomly assigned; it is therefore necessary to apply a method that controls for the self-selection of firms into the program. Our identification strategy consists of two steps. First, we construct a control group of firms. These firms did not participate in the program but have characteristics similar to the program's beneficiaries (before these beneficiaries took part in the program). We use propensity score matching (PSM) to find firms with similar characteristics. Second, we estimate the

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[11] It may be possible to identify these companies by looking at the physical records located in the CORFO's various regional offices (agentes operadores intermediarios). Because of time constraints and the work load of these regional offices, however, we decided not to pursue this option.

[12] Since we were not able to identify beneficiaries that completed their projects before 2004, it was not possible to rule out that some of these firms had been included in the control group. This could bias the results downward and result in an underestimation of the impact of the program.

[13] The Department of Economic and Tax Studies of SII graciously agreed to allow us partial access to their tax records following statistical reserve regulations and under monitored conditions.

[14] Only 0.03 % of the PDP's beneficiaries could not be successfully matched to SII's dataset—3 out of 9,099 firms. One of these firms' records, although present in SII's dataset, was empty. We believe that the record of the other two firms in the PDP's beneficiary dataset had some error in the tax identification number, which was why we could not match them to SII's dataset.

Table 1 Data available for the analysis

	Dataset used		Year when firm participation started						
			2003	2004	2005	2006	2007	2008	Total
Supplier firms	Original PDP's dataset		451	1,284	2,130	2,573	1,659	731	8,828
	PDP's and SII's dataset		451	1,284	2,128	2,572	1,659	731	8,825
	Firms used	Before matching	451	1,284	2,128	–	–	–	3,863
		After matching	⟵ 815 ⟶			–	–	–	815
Large firms	Original PDP's dataset		14	27	60	87	64	19	271
	PDP's and SII's dataset		14	27	60	87	64	19	271
	Firms used	Before matching	14	27	60	–	–	–	101
		After matching	⟵ 92 ⟶			–	–	–	92
All beneficiaries	Original PDP's dataset		465	1,311	2,190	2,660	1,723	750	9,099
	PDP's and SII's dataset		465	1,311	2,188	2,659	1,723	750	9,096
	Firms used	Before matching	465	1,311	2,188	–	–	–	3,964
		After matching	⟵ 907 ⟶			–	–	–	907

Supplier firms after matching only include firms in the agribusiness sector. The propensity score in the common support for supplier firms was truncated between 0.2 and 0.5 to guarantee that both treatment and control groups were balanced

effect of the program using the fixed-effect estimation on the set of treated and control firms. This identification strategy uses the panel structure of the dataset to control for observable and time-invariant unobservable factors that may affect firms' decision to participate (or not) in the program and the evolution of their outcome variables.

The average impact of the program is given by the parameters δ in the following estimating equation:

$$Y_{it} = \delta_1 P_{i,t-1} + \delta_2 P_{i,t-2} + \delta_3 P_{i,t-3} + \eta_t + c_i + v_{it}, \quad i \in C, \ t = 1, 2, \ldots, T \tag{1}$$

where Y_{it} is the value of the outcome variable Y for firm i in period t, $P_{i,t}$ is a variable that takes a value of 1 if firm i participates in the program in period t. Therefore, δ_1, δ_2, and δ_3 estimate the impact of the program one, two, and three periods after the firm participates in the program; η_t is a set of year dummies; c_i are time-invariant unobservable characteristics of firm i that could affect the decision of firm i to participate in the program, and the value of its outcome variable Y; and v_{it} can be interpreted as random shocks to the outcome variable that are not correlated with participation in the program or the observable characteristics. One of the main identification assumptions is that the correlation between participation in the program and the error term is through the time-invariant characteristics, c_i. Finally, C is the set of firms used in the evaluation. We show

results for firms belonging to the common support that we define using PSM.

This estimator is closely related to the difference-in-difference (DID) estimator[15] whose main identifying assumption is that, without the program, the trends of outcome variables for participants and non-participants are equal. Differences in the characteristics of firms that participated in the program and firms that did not can lead to different trends of outcome variables. In the presence of statistically significant differences in trends, the hypothetical scenario of a firm's performance in the absence of treatment is unrealistic, and consequently the DID estimator may be biased. To avoid this bias, Heckman et al. (1999) recommend that the DID be applied to a group of firms with similar characteristics defined using PSM.

There are several ways to carry out PSM; in general, results depend on the matching method and

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[15] See, for example, Wooldridge (2002, chap. 10), Cameron and Trivedi (2005, pp.768–770), or Angrist and Pischke (2009, chap. 5). The estimation of δ using the first-difference transformation of Eq. (1) is equivalent to the DID estimate. Note that the first-difference transformation provides a before–after comparison and the treatment dummy takes the difference between the treated and control groups. The within-group transformation is equivalent to this estimator if the time dimension of the panel is 2. In longer panels with strictly exogenous regressors, both the first-difference and within-group estimators have the same probability limit and differences between the estimators reflect the sampling error. The within-group estimator is more efficient.

the variables considered in the estimation of the propensity score. In this paper, we match observations using the nearest neighbor algorithm (one neighbor). This choice is appropriate when, like in our case, there is a large set of candidates to be used as controls. In the selection of the matching algorithm there is a trade of between efficiency and bias reduction. The method we select is the most conservative in terms of bias reduction because it matches each participant with a non-participant that has the nearest propensity score value (Caliendo and Kopening 2008).

We estimate the probability of participating in the program (propensity score) using a logit model and information from 2002—that is, the year before the beneficiaries started participating in the program. By doing this, the variables used to estimate participation in the program are not affected by the program.

The propensity score also allows for construction of a common support of firms. The common support comprises those firms that participated in the program and those non-participants, within the control group, with a propensity score in the range of values delimited by the minimum and maximum values of the propensity score for the participants.

4.2 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 suppliers and large firms, and Table 3 presents the results of the estimation. We estimate the probability that firms, both suppliers and sponsors, participated in the program between 2003 and 2008 using the firm's characteristics in 2002—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 3 to identify firms that did not participate in the program but that have the closest propensity score values to firms—suppliers and sponsors—that did participate in the program. Variables in the participation model include: geographical location; sector of economic activity; legal registration status at SII;[16] and firm

characteristics such as sales, number of workers, average salary paid, and a dummy variable that indicates if the firm exported at any point between 1998 and 2002. The model also includes the trends of these variables to ensure that firms were not only similar in 2002 but that they evolved in a similar way from 1998 to 2002.

Figure 1 shows the distribution of the propensity scores after matching for both supplier and sponsor firms. The Kolmogorov–Smirnov tests of the equality of distributions of the propensity scores indicate that, after matching and considering firms in the common support, the hypothesis that treated and untreated firms have equal propensity score distributions cannot be rejected—with a p value equal to 0.467 in the case of supplier firms and a p value equal to 1 in the case of sponsor firms (see Fig. 1).

Comparing the pseudo R^2 from probit estimations of the supplier firms' conditional treatment probability, we find that it decreases from 0.229 (before matching) to 0.008 (after matching), reducing the ability of the model to predict participation in the program after matching. The pseudo R^2 in the case of sponsor firms decreases from 0.285 (before matching) to 0.031 (after matching).[17]

After identifying the firms that are included in the control group—i.e., firms with similar values of the propensity score—it is necessary to check 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 verify this by: (1) 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

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Table 2 Variables included in the logit models

Variables	Description	Firm
Commercial legal entity	=1 if legally registered as a commercial legal entity; =0 if otherwise	Supplier
Natural person	=1 if legally registered as a natural person; =0 if otherwise	Supplier
North	=1 if located in Atacama or Coquimbo; =0 if otherwise	Both
Center w/o metropolitan	=1 if located in Valparaiso, Rancagua, or Maule; =0 if otherwise	Both
South	=1 if located in Bio Bio, Temuco, Los Lagos, or Los Rios; =0 if otherwise	Both
Extremes	=1 if located in Taparaca, Antofagasta, Coyhaique, Magallanes, Arica, or Parinacota ; =0 if otherwise	Both
Metropolitan area	=1 if located in the metropolitan area; =0 if otherwise	Both
Crop production	=1 if economic acivity within agrobusiness is crop production and horticulture; =0 if otherwise	Supplier
Animal husbandry	=1 if economic acivity within agrobusiness is animal husbandry; =0 if otherwise	Supplier
Agricultural production	=1 if economic acivity within agrobusiness is agricultural production; =0 if otherwise	Supplier
Agricultural service	=1 if economic acivity within agrobusiness is the provision of agricultural services; =0 if otherwise	Supplier
Forestry	=1 if economic acivity within agrobusiness is forestry; =0 if otherwise	Supplier
Agrobusiness	=1 if economic acivity is agrobusiness; =0 if otherwise	Sponsor
Manufacturing	=1 if economic acivity is manufacturing (non-metal); =0 if otherwise	Sponsor
Trade	=1 if economic acivity is whosale and retail trade; =0 if otherwise	Sponsor
Others	=1 if economic acivity is different from previous categories; =0 if otherwise	Sponsor
Sales (in logs)	Sales expressed in logs	Both
Sales trend	Average trend of sales (in logs) between 1998 and 2002	Both
Number of workers (in logs)	Number of workers expressed in logs	Both
Number of workers trend	Average trend of number of workers (in logs) between 1998 and 2002	Both
Salaries (in logs)	Salaries expressed in logs	Both
Salaries trend	Average trend of salaries (in logs) between 1998 and 2002	Both
Exporter	=1 if exported between 1998 and 2002; =0 otherwise	Both

variable on the treatment indicator); and (2) analyzing the overall measure of covariate imbalance before and after matching (that is, we estimated a probit model for program participation and ran a likelihood-ratio test of the joint insignificance of all the regressors before and after matching).

Table 4 shows the balance in the observable variables before and after matching for supplier and sponsor firms. 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 for both supplier and sponsor firms. In the case of supplier firms and after matching, the equality of means is rejected for some variables, indicated in Table 4. In the case of sponsor firms, it is not possible to reject the null hypothesis that the equality in means holds after matching for every variable.

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.

4.3 The impact of the program

As we mentioned previously, an important assumption to estimate the impact of the program is that, in absence of the program, the trend in outcome variables would be equal across treated and control firms. This counterfactual cannot be tested. But we can observe the outcome variables' trend before the program was implemented—in other words, the absence of the program in the case of firms analyzed—and test that the trends are the same for treated and control firms. Table 5 shows these tests for supplier and sponsor firms. These results indicate that, before the program

Table 3 Participation model

	Suppliers				Sponsor firms			
	Coef.	Std. Err.	z	P > $|z|$	Coef.	Std. Err.	z	P > $|z|$
Commercial legal entity	0.4588	0.1682	2.73	0.006				
Natural person	1.5319	0.1609	9.52	0.000				
North	0.8174	0.1486	5.50	0.000	1.0117	0.5599	1.81	0.071
Center w/o metropolitan	0.9310	0.1000	9.31	0.000	0.9765	0.3134	3.12	0.002
South	1.3726	0.1012	13.56	0.000	1.3820	0.2792	4.95	0.000
Extremes	1.0383	0.1731	6.00	0.000	−0.0759	0.7452	−0.10	0.919
Animal husbandry	−0.2394	0.0731	−3.28	0.001				
Agricultural production and animal husbandry	−1.4764	0.2551	−5.79	0.000				
Agricultural and livestock service	−2.3673	0.1372	−17.26	0.000				
Forestry	−2.7621	0.1575	−17.53	0.000				
Manufacturing					−0.2181	0.3319	−0.66	0.511
Trade					−0.0932	0.3297	−0.28	0.778
Others					−1.3000	0.4452	−2.92	0.003
Sales (in logs)	0.4081	0.0295	13.81	0.000	0.6640	0.1114	5.96	0.000
Sales trend	−0.1390	0.0612	−2.27	0.023	0.1388	0.1633	0.85	0.395
Number of workers (in logs)	−0.1862	0.0380	−4.91	0.000	−0.1219	0.1268	−0.96	0.336
Number of workers trend	0.0271	0.0997	0.27	0.786	0.6988	0.3496	2.00	0.046
Salaries (in logs)	0.1210	0.0275	4.40	0.000	0.1752	0.1491	1.17	0.240
Salaries trend	−0.0120	0.0607	−0.20	0.843	−0.4247	0.3413	−1.24	0.213
Exporter (=1 if exported between 1998 and 2002)	−0.5358	0.1569	−3.42	0.001	1.3658	0.2575	5.30	0.000
Constant	−11.4143	0.4291	−26.60	0.000	−22.6587	2.1960	−	10.32 0.000
Number of observations	8,158				10,008			
Pseudo R^2	0.2326				0.2720			

The dependent variable is a dummy for PDP participation (=1 if firm i receives treatment; =0 otherwise).

Source Authors' calculations

was applied, the variables on which we measure the program's impact had the same trend across treated and control firms on the common support.

Given that the trends in outcome variables across control and treated firms are not statistically different before 2003, it is safe to assume that—in the absence of treatment—annual sales, employment, and salaries for both groups of firms would have been the same. Under this key identifying assumption, we can assert that the PDP has had a positive impact on these outcome variables. Table 6 shows the average value of

outcome variables for treated and control firms both for supplier and sponsor firms from 2002 to 2008.

Table 7 shows the estimated results for each outcome variable for sponsor and supplier firms. For each outcome variable, we considered two models: one with two lags in the policy variable and one with three lags. Standard errors in all estimations are robust and clustered at the firm level.

Following the up to 6 months diagnostic stage, supplier firms in the agribusiness sector witnessed an average increase in sales of 16, 11, and 9 % 1, 2, and
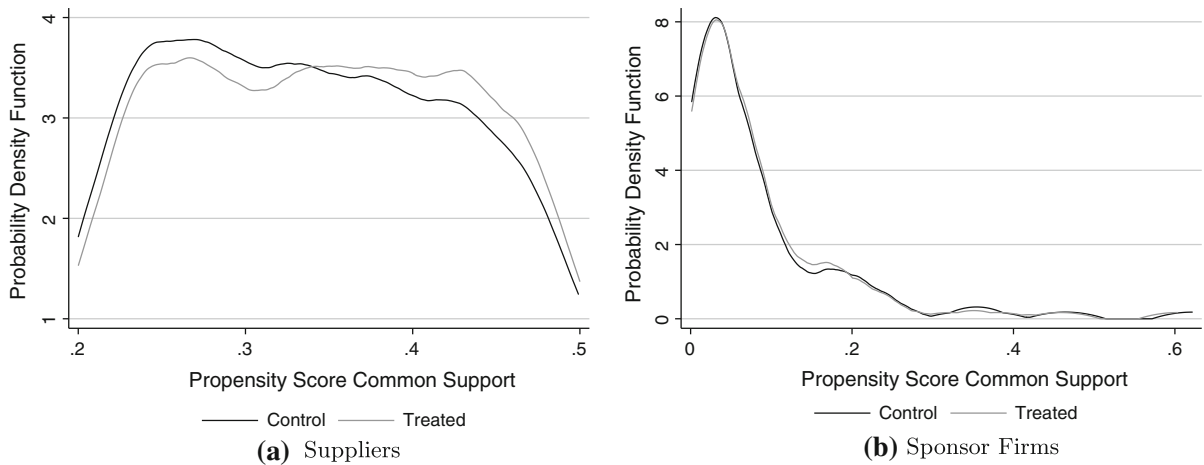
(a) Suppliers

(b) Sponsor Firms

Fig. 1 Propensity score distribution after matching

3 years after program approval, respectively. Employment followed a similar pattern: it increased 8, 9, and 10 % in 1, 2, and 3 years, respectively, after program approval. In addition to having a positive impact on sales and employment, the program had a positive impact on the average salaries paid by these firms: they increased 9, 16, and 8 % in 1, 2, and 3 years, respectively, after program approval. The joint increase in employment and wages reflects an increase in productivity.[18]

Moreover, although the program had no impact on the ability of the supplier firms to become exporters themselves, it had an impact on their sustainability and survival capabilities.[19] We might assume that this was accomplished by improving and stabilizing the commercial linkages between these supplier firms and their large firm customers. We estimate survival and export probabilities using linear probability models. Although this method is more restrictive assuming constant marginal effects, it allows us to easily control for fixed effects. This advantage is important when evaluating policies because participation in the policy

can be affected by unobserved time-invariant factors. On the other hand, the constant marginal effect can be thought of as the average effect of the policy. Supplier firms in the agribusiness sector that participated in the program were 2.5 % more likely to disclose positive sales 1 and 2 years after program approval, and 2.1 % more likely to disclose positive sales 3 years after than similar firms that did not participate in the program.[20]

The impact of the program on sponsor firms was limited to increases in sales and the ability of becoming an exporter. Contrary to the increase in sales witnessed by supplier firms the year following program approval, sponsor firms did not see an increase in sales until 2 years after program approval. Sponsor firms witnessed an average increase in sales of 19 and 25 % in 2 and 3 years, respectively, after program approval. The ability to become an exporter increased by 4.6 and 3.7 % in 2 and 3 years, respectively, after program approval. The program had no impact on the jobs the sponsor firms generated, the salaries they paid, or their sustainability.

It is possible that the program was able to achieve results in the short run because, as mentioned earlier, most projects were implemented in the agribusiness sector, where changes in production techniques and compliance with international standards may bear fruit in the short term for some crops. Blueberry exports,

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[18] Firms hire workers until the point at which the marginal product of labor is equal to real wages. Given that the marginal product of labor is decreasing in labor, the increase in real wages and employment has to be the result of a displacement to the right of the marginal product of labor—that is, an increase in productivity.

[19] We do not observe exit from the market but exit from the administrative records of SII. Therefore, we define sustainability as reporting positive sales for tax purposes (up to 3 years after initiating participation.

[20] A more appropriate method to measure firms' sustainability would be to use survival analysis techniques, for which one would need to observe firms for a longer period after participating in the program; there are not enough available data to do this analysis now.

Table 4 Balance in observable variables before and after matching

Variable	Sample	Mean		% Bias	% Reduction | bias |	t Test	P > | t |
		Treated	Control				
(a) Supplier firms							
Commercial legal entity	Unmatched	0.271	0.419	−31.70		−11.57	0.00
	Matched	0.351	0.359	−1.80	94.50	−0.35	0.73
Firm without legal status	Unmatched	0.028	0.081	−23.60		−7.89	0.00
	Matched	0.022	0.020	1.10	95.50	0.34	0.74
Natural person	Unmatched	0.702	0.500	42.10		15.44	0.00
	Matched	0.627	0.621	1.20	97.10	0.24	0.81
North	Unmatched	0.058	0.058	−0.20		−0.08	0.94
	Matched	0.086	0.070	6.70	−3,230.30	1.19	0.24
Center w/o metropolitan[a]	Unmatched	0.342	0.333	1.90		0.72	0.47
	Matched	0.434	0.380	11.50	−500.20	2.23	0.03
South[a]	Unmatched	0.461	0.337	25.60		9.76	0.00
	Matched	0.331	0.384	−10.80	57.80	−2.21	0.03
Extremes	Unmatched	0.040	0.045	−2.50		−0.92	0.36
	Matched	0.054	0.058	−1.90	23.40	−0.34	0.74
Animal husbandry	Unmatched	0.385	0.224	35.40		13.91	0.00
	Matched	0.350	0.381	−7.00	80.30	−1.32	0.19
Agricultural production and animal husbandry	Unmatched	0.010	0.031	−14.40		−4.78	0.00
	Matched	0.004	0.010	−4.30	69.80	−1.52	0.13
Agricultural and livestock service[a]	Unmatched	0.036	0.229	−59.10		−18.95	0.00
	Matched	0.012	0.002	3.00	94.90	2.32	0.02
Forestry[a]	Unmatched	0.028	0.164	−47.30		−15.16	0.00
	Matched	0.000	0.012	−4.30	90.90	−3.18	0.00
Sales (in logs)	Unmatched	17.906	16.956	54.00		18.96	0.00
	Matched	17.563	17.605	−2.40	95.50	−0.58	0.56
Sales trend	Unmatched	0.103	0.151	−7.30		−2.46	0.01
	Matched	0.105	0.105	−0.10	99.00	−0.02	0.99
Number of workers (in logs)	Unmatched	1.153	1.090	5.20		1.96	0.05
	Matched	1.137	1.169	−2.60	50.40	−0.51	0.61
Number of workers trend	Unmatched	0.077	0.096	−4.90		−1.74	0.08
	Matched	0.098	0.074	6.00	−22.70	1.26	0.21
Salaries (in logs)	Unmatched	15.709	14.982	35.10		12.46	0.00
	Matched	15.370	15.422	−2.50	92.90	−0.52	0.60
Salaries trend	Unmatched	0.179	0.208	−4.50		−1.58	0.11
	Matched	0.195	0.196	−0.10	97.50	−0.02	0.98
Exporter (=1 if exported between 1998 and 2002)	Unmatched	0.039	0.049	−5.30		−1.92	0.06
	Matched	0.050	0.048	1.10	78.40	0.22	0.83
(b) Sponsor firms							
North	Unmatched	0.043	0.046	−1.30		−0.12	0.90
	Matched	0.043	0.022	10.50	−702.30	0.83	0.41
Center w/o metropolitan	Unmatched	0.228	0.225	0.90		0.08	0.93
	Matched	0.228	0.261	−7.80	−787.50	−0.51	0.61

Table 4 continued

Variable	Sample	Mean		% Bias	% Reduction | bias |	t Test	P > | t |
		Treated	Control				
South	Unmatched	0.359	0.224	29.90		3.08	0.00
	Matched	0.359	0.370	−2.40	91.90	−0.15	0.88
Extremes	Unmatched	0.022	0.065	−21.30		−1.68	0.09
	Matched	0.022	0.022	0.00	100.00	0.00	1.00
Manufacturing	Unmatched	0.359	0.181	40.60		4.38	0.00
	Matched	0.359	0.391	−7.50	81.60	−0.45	0.65
Trade	Unmatched	0.359	0.417	−11.90		−1.12	0.26
	Matched	0.359	0.359	0.00	100.00	0.00	1.00
Others	Unmatched	0.098	0.260	−43.20		−3.54	0.00
	Matched	0.098	0.054	11.60	73.20	1.11	0.27
Sales (in logs)	Unmatched	22.681	20.155	172.50		18.50	0.00
	Matched	22.681	22.408	18.70	89.20	1.15	0.25
Sales trend	Unmatched	0.325	0.302	2.80		0.30	0.76
	Matched	0.325	0.482	−18.90	−585.70	−1.11	0.27
Number of workers (in logs)	Unmatched	4.532	2.649	106.80		11.32	0.00
	Matched	4.532	4.516	0.90	99.10	0.06	0.95
Number of workers trend	Unmatched	0.282	0.225	13.30		1.19	0.23
	Matched	0.282	0.311	−7.00	47.50	−0.46	0.65
Salaries (in logs)	Unmatched	20.061	17.820	132.50		12.63	0.00
	Matched	20.061	19.921	8.30	93.70	0.57	0.57
Salaries trend	Unmatched	0.260	0.337	−14.80		−1.18	0.24
	Matched	0.260	0.297	−7.10	51.90	−0.59	0.56
Exporter (=1 if exported between 1998 and 2002)	Unmatched	0.674	0.161	121.40		13.30	0.00
	Matched	0.674	0.750	−18.00	85.20	−1.14	0.26

Source Authors' calculations

[a] The equality of means is rejected after matching

for instance, grew on average 20.8 % per year in the last 4 years, while in the previous years exports were zero.[21] Additionally, the effect on suppliers can be faster than the effect on large firms because suppliers' customers are precisely those firms sponsoring participation in the program with full information about new production techniques, changes in management, and product quality. Therefore, any increase in the suppliers' production, presumably demanded by their sponsor, will be absorbed by their clients. In contrast, large firms need to market their products and prove to their clients that, by improving their suppliers' production standards, they can sell a better product.

[21] Data from ProChile, the Export Promotion Bureau.

5 Conclusion

This paper presents the impact evaluation of the Chilean Supplier Development Program implemented by CORFO since 1998. To the best of our knowledge, this is the first impact evaluation of a supplier development program in Latin America. The results presented in this paper are especially relevant because the Chilean Supplier Development Program was the basis for the design of other supplier development programs in Colombia, El Salvador, Mexico, and Uruguay.

The impact of the program was estimated using a panel that includes data from 1998 to 2008. This dataset contains information about firms' characteristics as well as outcome indicators for the the entire

Table 5 Tests for equality of trends ex-ante

Dependent variable	Sample	Untreated	Treated	Difference	p Value
(a) Supplier firms					
Annual sales (in logs)	All firms	0.1512	0.1030	0.0482	0.002
	Common support	0.1232	0.1046	0.0186	0.499
Employment (in logs)	All firms	0.0964	0.0767	0.0196	0.054
	Common support	0.0723	0.0978	−0.0255	0.245
Salaries (in logs)	All firms	0.2084	0.1792	0.0292	0.066
	Common support	0.2014	0.1953	0.0061	0.856
Number of observation	All firms	6,347	1,811		
	Common support	568	815		
(b) Sponsor firms					
Annual sales (in logs)	All firms	0.3016	0.3246	−0.0230	0.814
	Common support	0.4220	0.3246	0.0974	0.475
Employment (in logs)	All firms	0.2253	0.2817	−0.0564	0.178
	Common support	0.3022	0.2817	0.0205	0.755
Salaries (in logs)	All firms	0.3372	0.2595	0.0777	0.062
	Common support	0.2800	0.2595	0.0205	0.752
Number of observation	All firms	9,916	92		
	Common support	84	92		

Source Authors' calculations

Table 6 Descriptive statistics of the outcome variables and their evolution over time

	Firm sustainability		Annual sales (in logs)		Exporting firm		Employment (in logs)		Salaries (in logs)	
	Treated	Controls	Treated	Controls	Treated	Controls	Treated	Controls	Treated	Controls
(a) Supplier firms										
2002	0.991	1.000	17.695	17.619	0.014	0.021	1.079	1.182	15.395	15.478
2003	0.993	0.979	17.880	17.563	0.015	0.033	1.236	1.221	15.751	15.490
2004	0.991	0.935	17.943	17.504	0.017	0.039	2.066	1.781	15.909	15.461
2005	0.992	0.931	18.025	17.357	0.013	0.042	2.206	1.789	16.088	15.464
2006	0.979	0.884	17.915	17.321	0.013	0.032	2.277	1.817	16.158	15.579
2007	0.973	0.861	17.920	17.302	0.013	0.030	2.322	1.843	16.245	15.572
2008	0.957	0.857	17.971	17.339	0.009	0.028	2.299	1.824	16.210	15.545
(b) Sponsor firms										
2002	0.990	1.000	22.601	22.388	0.634	0.619	4.427	4.482	19.910	19.917
2003	1.000	0.988	22.705	22.380	0.703	0.548	4.653	4.516	20.024	19.980
2004	1.000	1.000	22.794	22.123	0.713	0.548	5.336	4.863	20.181	19.865
2005	1.000	1.000	22.914	21.998	0.713	0.476	5.542	4.845	20.412	19.900
2006	0.980	0.964	22.885	22.136	0.663	0.440	5.417	4.811	20.305	19.893
2007	0.970	0.952	22.904	22.085	0.663	0.429	5.525	4.780	20.380	19.941
2008	0.960	0.964	22.943	22.057	0.634	0.417	5.459	4.730	20.324	19.919

Controls on the common support

Source Authors' calculations

Table 7 Impact of the program on firm performance

Dependent variable	Firm sustainability		Annual sales (in logs)		Exporting firm		Employment (in logs)		Salaries (in logs)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(a) Supplier firms										
Dummy PDP = 1 ($t-1$)	0.0234***	0.0254***	0.1410***	0.1480***	−0.0019	−0.0019	0.0692**	0.0770**	0.0784**	0.0847**
	(0.0056)	(0.0057)	(0.0292)	(0.0291)	(0.0041)	(0.0040)	(0.0332)	(0.0327)	(0.0375)	(0.0374)
Dummy PDP = 1 ($t-2$)	0.0352***	0.0254***	0.1420***	0.1060***	−0.0017	−0.0017	0.1290***	0.0891**	0.1820***	0.1500***
	(0.0081)	(0.0070)	(0.0394)	(0.0325)	(0.0045)	(0.0038)	(0.0382)	(0.0349)	(0.0438)	(0.0396)
Dummy PDP = 1 ($t-3$)		0.0211**		0.0817*		−0.0000		0.0915**		0.0739*
		(0.0085)		(0.0427)		(0.0049)		(0.0422)		(0.0392)
Constant	1.0000***	1.0000***	17.6300***	17.6300***	0.0224***	0.0224***	1.2740***	1.2740***	15.6200***	15.6200***
	(0.0032)	(0.00317)	(0.0201)	(0.0201)	(0.0025)	(0.0025)	(0.0247)	(0.0247)	(0.0214)	(0.0214)
Number of observation	9,681	9,681	9,138	9,138	9,681	9,681	8,048	8,048	8,098	8,098
Number of firms	1,383	1,383	1,383	1,383	1,383	1,383	1,383	1,383	1,383	1,383
R^2 (within regression)	0.042	0.043	0.015	0.016	0.001	0.001	0.175	0.176	0.017	0.017
(b) Sponsor firms										
Dummy PDP = 1 ($t-1$)	−0.0083	−0.0077	−0.0057	0.0241	−0.0098	−0.0050	−0.0284	−0.0068	−0.1070	−0.0885
	(0.0107)	(0.0105)	(0.0875)	(0.0919)	(0.0279)	(0.0285)	(0.1060)	(0.1080)	(0.0896)	(0.0914)
Dummy PDP = 1 ($t-2$)	0.0093	0.0070	0.2800**	0.1700**	0.0638**	0.0455**	0.2030*	0.1230	0.1450	0.0759
	(0.0146)	(0.0101)	(0.1110)	(0.0837)	(0.0270)	(0.0221)	(0.1120)	(0.0962)	(0.1030)	(0.1070)
Dummy PDP = 1 ($t-3$)		0.0047		0.2270*		0.0365*		0.1690		0.1440
		(0.0150)		(0.1250)		(0.0219)		(0.1050)		(0.1010)
Constant	1.0000***	1.0000***	22.5700***	22.5700***	0.6420***	0.6420***	4.5170***	4.5170***	20.0000***	20.0000***
	(0.0041)	(0.0041)	(0.0693)	(0.0691)	(0.0224)	(0.0224)	(0.0780)	(0.0778)	(0.0506)	(0.0505)
Number of observations	1,232	1,232	1,176	1,176	1,232	1,232	1,159	1,159	1,166	1,166
Number of firms	176	176	176	176	176	176	176	176	176	176
R^2 (within regression)	0.020	0.020	0.012	0.015	0.038	0.039	0.115	0.116	0.016	0.018

Source Authors' calculations

* Significant at $p < 0.10$, ** significant at $p < 0.05$, *** significant at $p < 0.01$

population of tax-compliant Chilean firms. Thanks to access to microeconomic data provided by CORFO and SII—the Chilean tax authority—under monitored conditions, we had the opportunity to identify the PDP's beneficiaries within the dataset and to select an appropriate control group with characteristics similar to those of the program's beneficiaries.

We applied a combination of econometric methodologies—PSM and fixed-effect estimation—to gauge the causal effect of the program. DID allows us to control for unobservable time-invariant characteristics that might affect participation and outcome variables, as long as the trend in outcome variables in the absence of the program is the same for treated and control firms. PSM makes this assumption credible by restricting the analysis to those firms with similar characteristics; including firms whose outcome variables before the program was applied exhibit similar trends.

We find that the program benefited both supplier and sponsor firms. This is an important finding because it shows that cooperation can simultaneously help SMEs and large firms. In the case of suppliers in the agribusiness sector, the program helped them increase sales and employment, and positively affected their sustainability. In the case of sponsor firms, the program contributed to increasing sales and positively affected their ability to become exporters.

Our results also show that the effect of the program can be observed sooner among suppliers than among sponsor firms. The effect on suppliers in the agribusiness sector could be seen 1 year after the firms first started participating in the program. The effect on sponsors, meanwhile, appeared only 2 years after the firms' suppliers first started participating in the program. This finding is intuitive: suppliers' clients—i.e., the sponsor firms—know first-hand about their providers' improvements in production techniques, management, and product quality and are prepared to absorb their suppliers' increases in production (increases that were presumably demanded by the clients themselves). In contrast, sponsor firms have to prove to their international and domestic clients that their product have improved, thanks to their suppliers.

Our findings suggest that the Chilean Supplier Development Program has achieved its objective of improving and stabilizing the commercial linkages between small and medium-sized suppliers and their large firm customers. After participation, suppliers are more likely to survive in business—report positive sales—than similar firms who did not participate in the program, and both suppliers and sponsor firms benefit from larger sales. Although the program was not explicitly designed to promote exports but instead to comply with international production standards as outlined by trade agreements, the results show that it has helped sponsor firms become exporters. In addition to its explicit and implicit objectives, the program has contributed to the creation of employment by supplier firms and an increase in the salaries these firms pay to their employees.

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