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The Impact of an Associative Strategy (the PROFO Program) on Small and Medium Enterprises in Chile

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The Impact of an Associative Strategy (the PROFO Program) on Small and Medium Enterprises in Chile [*]

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Abstract

The main objective of this article is to determine if associative strategies followed in Chile have had any impact on the enhancement of productive performance of Chilean SMEs firms. In order to do that, the estimate of the impact is approached using the benchmark given by Social Experiment but within the context of a `non-experimental' evaluation design. We conclude that these kinds of policies have been effective in increasing the productivity of the participating firms, and have also been efficient since they have achieved high social profits.

Keywords : program evaluation, associative strategies, SMEs, innovation, non-experimental design.

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1 Introduction

In the course of the last decade the Government of Chile has designed and managed a group of Programs of Managerial Development directed at increasing the productivity of small and medium enterprises (SMEs) segment of the economy. These programs were designed with the assumption that the standard of life of the majority of the Chileans is, directly or indirectly, related to the employment and the wages paid in this stratum.

While it is relatively well documented that Chilean industrial productivity is growing with relative vigour (see Fuentes (1994) and Engel, et. al (1996)), the structural heterogeneity among the large and small companies has not shown any evidence of decrease. Table 1 shows that Chilean firms with more than 50 workers have a labour productivity double those with less than 50 workers.

[Table 1]

This gap also results in significant differences in the wages that the two types of companies pay. Besides that, the employees of SMEs receive, in general, lower Public Health coverage and, according to the international evidence, also have a 50% higher probability of losing their jobs than employees of large company (Davis 1993). There are alternative explanations for this situation, between them:

Economies of Scale
The typical argument is that in SMEs the unit costs of production are higher as a result of indivisibilities in physical and human capital that, because of lower production levels, impede them from exploiting economies of scale.

Smaller investment in physical and technological capital
Data from the last Chilean Annual Industry National Survey (ENIA) show that the investment rate for the SMEs is only 50% that of the largest companies. Also, the first Survey of Technological Innovation in the Manufacturing Industry indicates that while 89% of large Chilean plants have bought machinery and equipment in the last 3 years, only a 62% of SMEs have done the same. Also, while 88% of the machines bought by the large companies were new, this figure is only 65% in the case of the SMEs, and finally, while 82% of this equipment had electronic controls, this percentage in the case of the SMEs decreases to 45%. Obviously those numbers reflect a lower rate of diffusion of information technology within this group of firms[1].

Theoretically, it is possible to recognise two complementary forces as causing this poor performance. On one hand, the credit restrictions placed on the SMEs are well documented[2]. A second problem is the inability of management to select new technologies, as well as to adapt them successfully. There are, unfortunately, too frequently cases where a small firm has gone deeply into debt to buy machinery that it cannot put into operation. Indeed, the above mentioned survey of

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[1] More details about the first Survey of Technological Innovation in the Chilean Manufacturing Industry can be found in Benavente & Crespi (1995,1996) an the works cited there in.

[2] Agosin, Crespi & Letelier (1996) clearly shows that there exist a negative relationship between firm's internal savings and size. Therefore, long term saving decistions in smaller firms are more vurnerable to short term financial and economic shocks.

technological innovation also showed that, while 67% of the large firms respond that the lack of qualified people is an obstacle to innovation, the figure ascends to 75% for the SMEs.

Reduced organisational skills

Productivity growth also depends on the organisation of capital and labour in the plants. But to do that specific skills are required to operate and to control the productive process and the administration of the business. The frequent lack of those abilities in the managers becomes a strong factor impeding better performance of the productive processes in these types of companies. Also, high search cost, added to the lack of experience, also contributes to worsening the performance of management.

Weakened negotiation ability

The SMEs are, in many cases, suppliers of services, materials and parts to large companies. The uneven distribution of the power among the parties has frequently led to renegotiations of contracts where the large firm demands price reductions and thus captures the productivity earnings achieved by the SMEs. This takes into account the fact that the real productivity gap probably is not as large as the one measured by using nominal values, but the effect on the wages of workers is the same.

It is necessary to add to the previous elements that although Chile has an incipient National System of Technological Extension, the problems of the SMEs to get in contact with it are also significant. Indeed, while 68% of the largest Chilean industrial companies have had some technological assistance from an institution providing technological services, the percentage in the case of the SMEs falls to 16%. While 30% of the large companies have had contacts with universities, only 11% of the SMEs have done the same.

From all the above, it is easy to diagnose that, besides the failures of the markets, the complete isolation from the public and private extension institutions worsens the situation of SMEs even more.

If structural heterogeneity, low wages and the high probability of failure are the problems resulting from failures of the markets in which the SMEs operate, are the extension programs which have been implemented an appropriate response? This document presents the most important findings of one of the first evaluations carried out on one of the Programs of Development (known as PROFOs).

The central hypothesis for the design of the PROFO program is that the main problem of the SMEs is not their size but rather their complete isolation. For this reason, the decision was made to transfer resources to groups of firms, instead of individual companies (Montero 1995). The externalities that are generated when making up the PROFO groups constitutes an opportunity for the companies to improve their access to the internal and external markets, to transfer technology, to modernise management and to contribute to local development.

Formally, a PROFO is an associative entity with a legal constitution that brings together small and medium firms from the same industrial branches and regions for a limited period of 3 years at most. A manager hired by the members is in charge of administration and public and private resources are used to finance operation costs. Responsibility for coordination and evaluation falls on the National Agency for Development (CORFO).

CORFO is responsible for regulating the general framework that sets forth the program and to approve and assign the financial resources. Intermediate operators are put in charge of field operations. Some of those are public organisms such as the Service of Technical Cooperation (SERCOTEC) others are private associations (for example the Association of Manufacturing Exporters

-ASEXMA-, or the Textile Institute). CORFO works as a support agency, and it does not have any direct participation in execution.

The administration of the program has been decentralised over time. In the beginning SERCOTEC was the institution that ran the first PROFOs, due to their direct contact with the SMEs,. However, starting in 1994, it was determined that the execution of the program could be transferred to private operators properly authorised by CORFO. The objective of this decision was to accelerate diffusion and to lower administration costs. An interesting innovation has been to consider union associations as possible operating agents.

Those intermediary agents are key in coordinating participants in the formulation of common or associative projects and in promoting access to other more specific State instruments. For example, many of the PROFO member firms apply to the Fund of Technical Assistance (FAT) in order to get financing. Another institution used is ProChile, in order to get resources for international fairs and trade missions. A few of them also apply for grants for the support of technological development projects.

But additionally another objective that it is sought with this type of association is to enhance the learning process of the firms. This can be achieved by firms specialising in their products, which have a competitive advantages in order to get scale economies, and in addition can improve the negotiating ability of the firms with their clients and suppliers.

The first PROFOs began in 1992 and from that date they have multiplied each year. At the time of its first evaluation -1997- 29 of these groups had already completed a cycle with the participation of 250 companies. During that time, the program has acquired more relevance, the number of firms involved and the amount of resources invested have increased rapidly. In this context, defined by a high degree of institutional innovation, the necessity of evaluation instruments becomes critical.

The Chilean Ministry of Economics and CORFO are responsible for establishing the general policy framework, and for the evaluation of programs carried out by other agencies. In order to fulfil that mission, these institutions asked the Department of Economics of the University of Chile to implement a methodology that allows evaluation of the PROFO Program impact[3].

In most countries, development agencies do not have units that can carry out the evaluation process of the programs implemented. It is, also, not recommended that an organism (public or private) evaluate itself because of the distrust generated regarding the results. For that reason, these institutions now look to independent entities like Universities, international institutions and private consultants to fill that role. This paper summarises some of the findings of this evaluation study.

2 The Design of the Evaluation

The evaluation represents an advance, relative to standard practice, in three fundamental dimensions. First, it set out to establish a clear relationship among actions taken by firms in general, actions taken as a result of services received within the context of the program, and economic results. Second, it measured the net result of the program by controlling for general conditions corresponding to each productive sector and company and, third, it incorporates cost-benefit results.

In order to fully consider the effects of the PROFO, the study focused on the analysis of PROFO firms that had completed their three-year cycle. The starting point of the design was to revise a series

[3] Main results about this evaluation can be found in Universidad de Chile (1997); a summary of them in Benavente (1999).

of documents and secondary data given by the state agencies. This was done in order to determine the type of action taken by the firms and services provided by training service providers. However, the most important methodological tool was the design and completion of a direct field survey that covered the following topics:

Identification and Economic Characterisation of the Firm

In this section of the survey we proceeded to get information such as the name of the company, address, year of starting activities, and ISIC code. One problem that we had to solve at his level was related with the definition of the experimental unit. For this study, keeping in mind the necessity to obtain information related to technological issues in the business, the most suitable experimental unit is the plant not the company. However, this can cause problems when evaluating the technological facts of multi-plant companies. Since this survey was guided to SMEs, this last problem was not relevant and when it was presented, technological information was collected for the plant level, while administration information was obtained for the company level.

Competitive Performance

In this section of the survey information related to a firm's economic behaviour was requested for the last four years (1992-1995) . The following variables were measured:

- Main products
- Employees (permanent and part-time)
- Wages
- Raw-material costs
- Sales
- Exports
- Investments

This information was collected with the objective of facilitating comparability with national statistics, thus we followed the methodological approach of the Chilean Annual Industrial National Survey (ENIA) and the Survey of Investment, carried out periodically by the Chilean National Institute of Statistics (INE).

Management and Technological Innovation

In this section, information related to administration of the business and production organisation was requested for the last four years. In particular, we asked for the following:

- Changes in global administration
- Innovations of the productive process
- Product Innovations
- Administration of human resources

Most of these topics require questions which have only qualitative answers. As a consequence, the design of the survey for this section included multiple choice questions. The format of the survey followed the general recommendations of the Chilean Survey of Technological Innovation in the Manufacturing Industry (INE 1995).

The development of Innovative Skills

In this section we requested information concerning the future plans of innovations that firms expect to make in the near future in order to generate improvements in competitiveness. It also collected information related with what means the innovations projects will put into practice. We asked for plans not only regarding global administration, but also for the production process, products, human resources, and for the interaction with clients, competitors, suppliers and institutions.

In particular, we proceeded to ask about how much the firms would be willing to pay to obtain technical assistance in areas such as design of new products, training of human resources, participating in technological exhibitions, and other activities related to the absorption of modern technology. Again, this part of the survey followed the general items of the Survey of Technological Innovation in the Manufacturing Industry (INE 1995).

Revealed preferences for the Instrument
This topic was approached by means of incorporating specific questions that allow to measure the preferences of the firms for the PROFO program as well as the main advantages and disadvantages associated with it.

During a whole month a pre-test was done for the purpose of testing the effectiveness of the questionnaire in obtaining the information required; and then during the three months period the field work was carried out. The population of companies rose to 257, out of which 102 with complete information were obtained.

3 Methodology : Natural Experiments with Non Experimental Design

A major problem when developing an evaluation of a promotion program is how the real impact of it is measured. In this section we explain the traditional and modern techniques oriented to isolate the net effect of the program on the treated firms. We describe the most common sources of error while measuring the impact and we suggest their main solutions. The application of this methodology for the Chilean PROFO Program is presented in the next section.

3.1 The Traditional Solution to the Evaluation Problem[4]

All evaluation implies to make some comparison between companies `treated' and those `not treated'. This section considers the most common estimator used in the empirical literature to measure the average impact of the treatment on a participant (the treated), this estimator is known as the Before-After Estimator.

In this method the strategy consists of comparing the firm with itself. Because firms can be in two states (treated or not treated) only in different moments, the method assumes that the results

[4] This subsection is based in Heckman, Lalonde & Smith (1998) and in the seminars given by Heckmand and Todd in Santiago of Chile, October 1999.

measured in any state are a good approach for the results for the same state at another moment in time. To apply this method, data for the participants are only required at two moments: `before' being part of the program and `after' it.

For example, if our interest is in measuring the impact of the program on the productivity growth of a company. If we can measure the productivity of company ***i*** after the PROFO Program, in the moment ***t***, and the productivity of the same company before participating, that is to say at the moment ***t'***; then the impact of the program on ***n*** participant companies can be measured as:

$$\alpha = \left(\overline{Y}_{1t} - \overline{Y}_{1t'}\right) \quad (1)$$

where:

$\overline{Y}_{1t}$: The average productivity of participant companies `after' of the program (moment t).

$\overline{Y}_{1t'}$: The average productivity of participant companies `before' of the program (moment t ').

The main advantage of this method is that it only requires data on the participants in two moments of the time: before and after the participation. The main disadvantage is that it assumes that the productivity of the participants in the state non-participation would be the same as they would have had before participating. This implies that the productivity of the companies must have remained stagnant for the case where they had decided not to be part of the program. Changes in the general state of the economy or in the position of the company along its cycle of life (for example: learning processes) can make this estimator totally invalid.

An important element that this method does not control is that companies may decide to participate in the program after experiencing negative shocks in performance. It is in these moments when changes can be made in the plant, or certain improvements introduced without stopping the production line. However, if these shocks are transitory and productivity shows mean reversion, the productivity `without program' would grow anyway. In this situation we would attribute results to the program that are the natural consequence of economic recovery. Only if the shock is permanent does this procedure will give appropriate results for the impact of a program[5].

3.2 The Suggested Solution from the Experimental Method.

The previous discussion should drive to the search of a method that allows determining that, indeed, measured changes are the result of the program and not a mere consequence of the evolution of environmental conditions. For that, some type of control group will necessarily be required.

To illustrate the method let us consider that we want to evaluate the effect of a program on the productivity of a firm. The standard procedure in this case consists of obtaining a sample of m=2n firms that want to participate and to assign `at random' the treatment D (the participation in the programs) to a half of the sample. The other half is excluded and forms a control group that can be used to build the scenario `without program' that determines what would have happened to the participants in the program if they had not participated.

This procedure implies gathering productivity information (or other variable of interest) before and after the program for two groups of companies: the participants and the control group. In this context, the experimental method suggests that an appropriate estimator of impact is the Differences in

[5] Examples of these applied to the labour markets can be found in Ashenfelter (1978).

Differences estimator, which compares productivity growth for the participants with productivity growth of companies in the control group. In other words, the differences in differences estimator is:

$$\alpha = \left(\overline{Y}_{1t} - \overline{Y}_{1t'}\right)_1 - \left(\overline{Y}_{ot} - \overline{Y}_{0t'}\right)_0 \quad (2)$$

where:

$\left(\overline{Y}_{1t} - \overline{Y}_{1t'}\right)_1$: It is the average productivity growth of participant firms (identified with a 1)

$\left(\overline{Y}_{ot} - \overline{Y}_{0t'}\right)_0$: It is the average productivity growth of control firms (identified with a 0).

In a rigorous sense, this estimator can be reduced only by comparing the differences of productivity levels between the two groups at the end.[6] The random nature of the assignment of the companies to each group assures that the productivity average of both groups before participating is the same, in other words, this estimator can be written as:

$$\alpha = \overline{Y}_{1t} - \overline{Y}_{ot} \quad (3)$$

where:

$\overline{Y}_{1t}$: It is the average productivity level of the participants `after' participating

$\overline{Y}_{0t}$: It is the average productivity level of the controls `after' participating.

If the companies have been assigned at random to both groups, then we can be certain that any transitory shock in the `before participating' state would affect both groups and we would have an appropriate estimate of the impact of the program. The problem arises when the assignment is not random, or when another type of restriction impedes giving a placebo to the control group.

3.3 Alternative Solution when the Design is Not Experimental

The problem with the estimating the impact of the program occurs when assignment of the companies is not at random. This is the typical situation where managers of the programs define certain very general conditions of eligibility, then assign services according to the interest of the participants, and finally they obtain a comparison group from a parallel survey or database. In this case we risk the presence of a ` selection bias' problem.

Selection can be due to the individuals' own expectations of the program (self-selection) or by the decisions of program manager. In this scenario, personal incentives and the incentives of program managers can strongly affect the decision to participate.

In order to study productivity we could specify a model of the production function where the added value of each company depends on certain inputs such as employment and capital. Let us suppose that information on these variables is collected in the vector x_i. We can model the added value of each participating company by the following expression[7]:

$$y^1{}_i = x_i \beta^1 + u_i^1 \quad (4)$$

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[6] In which case it then became a cross-section estimator.

[7] A Cobb-Douglas function, for example.

where *u* summarizes other non-observable characteristics of the company that influence production. Likewise, for the members of the control group we have production as given by the following expression:

$$y^0{}_i = x_i \beta^0 + u_i^0 \quad (5)$$

Following Heckman (1998), both models can be collapsed into a single expression where the observed result depends on which group the company is in:

$$y_i = Dy_i^1 + (1-D) y_i^0 \quad (6)$$

where *D=1* if the company is in the treatment group and *D=0* if the company is in the control group. By using the above expressions we have that the production `observed' for each company is given by:

$$y_i = x_i \beta^0 + Dx_i(\beta^1 - \beta^0) + u_i^0 + D(u_i^1 - u_i^0) \quad (7)$$

If in addition we simplified the model by assuming that the coefficients of slopes of the two models are the same[8] with the exception of a constant which, is supposed attributed to the program, and that non-observable factors are also the same for both groups. That is to say:

$$\beta_j^1 = \beta_j^0 \qquad j = 1, \ldots\ldots, K$$

$$u_i^1 = u_i^0$$

Then the previous model can be written:

$$y_i = x_i \beta + \alpha D + u_i \quad (8)$$

where the estimated value for α is the program impact on productivity. When there is an experimental design and assignment is made at random, the estimate of expression (8) for any conventional method such as OLS will give appropriate estimators of the impact. These results will be equivalent to that of expression (3) above[9].

To study how a non-experimental design affects the results we proceed by assuming that in some period ***t*** after the participation in the program, we decide to evaluate its impact on the productivity of the participant, but we only have information about them after completing their participation. In order to do that, we compare their production with a sample of non-participants selected from a secondary database, for the same period of time. The average production of the participants after the program, it is given by:

$$E\,[y_{it}^1 \mid x_{it}^1, D=1] = x_{it}^1\ \beta + \alpha + E\,(u_i \mid D=1) \qquad t > k \quad (9)$$

Where x_i are variables that represent the `observed' characteristics of a company that influence its production: typically employment and capital. K represents the moment of participation. The expectation of u_i, conditioned for the decision of participating, shows the correlation among non-

[8] Meaning that the impact of the capital or another input over the productivity is the same independently of the participation in the program.

[9] However, randomness fails when it influences the self selection process of firms, when drop-outs exists or when substitutes services can be obtained by the control group (contamination bias).

observable variables that impact production and the decision to participate in the program[10]. Finally, α is the average impact of the program. Likewise, revenues for the group of non-participants are given by:

$$E[y_{it}^0 \mid x_{it}^0, D=0] = x_{it}^0\beta + E(u_i \mid D=0) \quad t>k \text{ (10)}$$

The idea is to use the results of this group of non-participants to determine the contra-factual scenario of what would have happened to the participants in the case of them not having participated. The average impact of the program, therefore, will be given by:

$$E[y_{it}^1 \mid x_{it}^1, D=1] - E[y_{it}^0 \mid x_{it}^0, D=0] = (x_{it}^1 - x_{it}^0)\beta + \alpha + E(u_i \mid D=1) - E(u_i \mid D=0) \text{ (11)}$$

The estimate of impact of the program α will be strongly biased, due not only to differences between observable characteristics, but also to non-observable variables for firms of both groups. However, if the selection of the control group were done in ways that assure that they have observable characteristics similar to those of the participants, a large decrease in the bias would result. However, the non-observable bias will still remain. In other words, the impact estimator would remain biased as we can see in the following expression:

$$E[y_{it}^1 \mid x_{it}^1, D=1] - E[y_{it}^0 \mid x_{it}^0, D=0] = \alpha + E(u_i \mid D=1) - E(u_i \mid D=0) \text{ (12)}$$

When there is a non-experimental design where no group of eligible firm is randomly restricted from participating, how can the impact estimators be obtained? Suppose now that we have pre-treatment information that is collected at the moment of enrolment in the program (t' previous to k). The production results before participating for the future participants it will be given by:

$$E[y_{it'}^1 \mid x_{it'}^1, D=1] = x_{it'}^1\beta + E(u_i \mid D=1) \quad t'<k \text{ (13)}$$

While the result for the non participants is the following:

$$E[y_{it'}^1 \mid x_{it'}^1, D=0] = x_{it'}^1\beta + E(u_i \mid D=0) \quad t'<k \text{ (14)}$$

A consistent estimator of average impact of the program is the `Differences in Differences' estimator. Firstly, we calculate the difference between the results after the program (t) and before the program (t') for the participants. This removes the correlation among the non-observable variables and the decision to participate for this group:

$$E[\Delta y_{it}^1 \mid x_{it}^1, x_{it'}^1, D=1] = E[y_{it}^1 \mid x_{it}^1, D=1] - E[y_{it'}^1 \mid x_{it'}^1, D=1] = (x_{it}^1 - x_{it'}^1)\beta + \alpha \text{ (15)}$$

Secondly, we proceed in the same way for the comparison group:

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[10] Note that u_i has no temporal index. This due to the assumption that non observable factors remain constant (or fixed) through time.

$$E[\Delta y_{it}^0 \mid x_{it}^0, x_{it'}^0, D=0] = E[y_{it}^0 \mid x_{it}^0, D=0] - E[y_{it'}^0 \mid x_{it'}^0, D=0] = (x_{it}^0 - x_{it'}^0)\beta \quad (16)$$

Finally we compute the difference between the expressions (15) and (16), and thus obtain:

$$E[\Delta y_{it}^1 \mid x_{it}^1, x_{it'}^1, D=1] - E[\Delta y_{it}^0 \mid x_{it}^0, x_{it'}^0, D=0] = (x_{it}^1 - x_{it'}^1)\beta - (x_{it}^0 - x_{it'}^0)\beta + \alpha \quad (17)$$

If both groups can be selected so that the evolution of their observable variables it is the same over the time, then (17) can be written as:

$$E[\Delta y_{it}^1 \mid x_{it}^1, x_{it'}^1, D = 1] - E[\Delta y_{it}^0 \mid x_{it}^0, x_{it'}^0, D = 0] = \alpha \quad (18)$$

In this way we will be able to estimate the impact of the program appropriately. The method of differences in differences, however, has some disadvantages. First, although it does not assume that there is a control sample randomised as an experiment, it still assumes the existence of information for a comparison group in at least two moments: before the program and after it. Also, it is assumed that the correlation between non-observable variables and the decision to participate are constant over time (a fixed effect). Finally, in third place it assumes that impact of the program is a fixed constant α for all participants[11].

3.4 Matching Methods[12]

The previous results were built on the assumption that, controlling for the observable characteristics of the exogenous variables, the firms were identical at the moment of deciding to participate in the program. This leads to compare firms that are inside the same `support' of observable characteristics. However, this procedure ignores the fact that the distribution of probability of each group inside the support can be different. This implies that we must re-weight the companies in the control group.

Similar to the differences-in-differences estimator, what matching does is to compare the changes in results (for example, productivity) for the participants to results for members of the control group, where the change is measured in relation to some benchmark pre-program situation. As was mentioned before, this estimator has the advantage of removing any non-observable time-invariant differences among the individual firms of both groups. But it also allows re-weighting the distribution of probability for the control group.

This estimator requires cross section data on participants and non-participants at two moments in time. Let us define t and t' as two periods of time; one after the start date of the program and other before, respectively. Y_t^0 is the result observed at moment t in the non-participation state and $Y_{t'}^0$ is the result observed at the moment t in the participation state. A necessary condition to justify application of the method is:

$$E[Y_t^0 - Y_{t'}^0 \mid P(X), D=1] = E[Y_t^0 - Y_{t'}^0 \mid P(X), D=0] \quad (19)$$

[11] Then heterogeneity can not be fully captured.

[12] This subsection is based in Heckman, Ichimura, Smith & Todd (1998).

What that means is that conditioned for the probability of participating, the average growth of the control group is equivalent to what participant group would have had, the if the firm had not participated. Under these conditions the impact estimator for the participants will be:

$$\hat{\Delta}^{DID}_{D=1} = n_i^{-1} \left\{ \sum_{i=1}^{n_i} \left[(y^1_{it} - y^1_{it'}) - \hat{E}[y^0_{it} - y^0_{it'} \mid P(x_i), D_i = 0] \right] \right\} \quad (20)$$

where:

$$\hat{E}[y^0_{it} - y^0_{it'} \mid P(x_i), D_i = 0] \quad = \quad \sum_{j=1}^{n_j} W_j\left(P(x_j)\right)\left[y^0_{jt} - y^0_{jt'}\right] \quad (21)$$

Where n_i is the number of observations for the treatment group (in this case the same one for every period) and n_j is the number of observations of the control group. The key to the method is in the construction of the estimator $\hat{E}[y^0_{it} - y^0_{it'} \mid P(x_i), D_i = 0]$. In this case, the non-parametric regression approach was applied (kernel regression matching estimator). This estimator chooses the weighting in a such way that closer observations in terms of distance $\left| P(x_i) - P(x_j) \right|$ receive more importance. This re-weighting is reached by means of a kernel function. In other words, the weights are:

$$W_i\left(P(x_i)\right) = \frac{K\left(\dfrac{P(x_i) - P(x_k)}{h_n}\right)}{\displaystyle\sum_{\substack{k=1 \\ \{D_k = 0\}}}^{n_0} K\left(\dfrac{P(x_i) - P(x_k)}{h_n}\right)} \quad (22)$$

In this exercise the function used corresponds to `bi-weight kernel' it is given for:

$$\begin{aligned} K(s) &= \frac{15}{16}\left(s^2 - 1\right)^2 \quad for \quad |s| < 1 \\ &= 0 \quad otherwise . \end{aligned} \quad (23)$$

Where s is the expression within parenthesis in the numerator of (22) and h is the bandwidth[13]. In this case we use a fixed bandwidth h. Since P(X)'s are in the interval (0, 1) an appropriate h should be in the interval 0.2 at 0.4[14]. Next, the sensitivity of the estimates with respect to the choice of bandwidth should be examined.

[13] Intuitively, a bandwidth refers to the interval length chosen to determine the number of the nearest neighbours around a centre in x_i.

[14] See Heckman et al (1998) for a discussion about this point.

4 Results of the Application for the PROFO Program

The data for the estimate of the impact of the program were obtained by means of a survey applied to a random sample of 102 participating firms that responded to our request for information about their performance before and after having concluded the period of participation. Once this sample was obtained, the Chilean National Institute of Statistics (INE) was asked to give a sample of control firms selected at random from a population in the same productive sectors and having similar sizes to the participant firms.

However, for these control companies there is no information about the types of innovations and changes of skills made by the companies during the three years of the Program. To have an idea of the contra-factual scenario for the observed qualitative changes, we asked the participant companies to indicate if they had made a certain type of innovation and in the case an affirmative response, if that innovation had been a consequence of the program.

4.1 Impact Results at a Qualitative Level[15]

In table 2 the results are presented according to the frequency of positive answers. The second column presents the percentage that, out of total of answers, the managers have suggested that the change was a consequence of the program. Finally, in the third column we measured an indicator called `Rate of Impact', that captures the ratio between the first two columns. This measurement tries to identify what types of innovations are more sensitive to the presence of the program.

Regarding management of the firms, interviewees have manifested that the most significant advances were concentrated in the organisation of the production process, the implementation of marketing strategies and in identifying the most profitable products. In all of these areas the significance attributed to PROFO has been relevant.

[Table 2]

Regarding to innovation of the production process, the most significant results were concentrated in the introduction of quality control and production planning. In relation to the management of the human resources, the benefits have been concentrated in the training of managers and personnel in that order.

Another area where PROFO appears to have generated significant difference is in higher capacity of the companies to access the National Industrial Extension System. Indeed, the participating companies had higher frequency of affirmative response to questions such as \Did you improve access to support instruments?", \Did you practice technical co-operation with competitors?", \Have you tried co-operation with private consultants?" and \Has there been improvement in access to public financing?".

[15] A detailed description about the impact of the program can be found in Universidad de Chile (1997).

In summary, areas that were most sensitive to the program were marketing strategies, the introduction of data collection systems, training at any level, improvements of the commercial relationships with suppliers and clients, and the relationships with public institutions and private consultants.

4.2 Quantitative Differences among Firms of Both Groups

The first step in addressing the evaluation of the quantitative impact of the program is to examine the differences in firm characteristics for the two groups.

Table 3 shows the differences in the sectoral distribution of the firms. Given the form by which the control group was selected, a high degree of similarity is observed in this distribution. In fact, a test of equality of distributions was not rejected[16].

The situation is different when we analyse the scale results. Indeed, because the INE tends to collect information for larger firms, the control group it generated had companies that were, on average, statistically larger than the participant companies (tables 4 and 5).

[Table 3]

[Table 4]

[Table 5]

As can be seen in Tables 4 and 5, the control companies were larger than the treatment group in the period before the program. The difference was clearly larger for added value than for employment, which means that the control companies had a higher labour productivity than the participants `before' participating.

A problem with the previous analysis is that it is based on individual variables, it would be useful to have a multivariate estimator of the differences between the two groups for the base period (t'). In order to do that, we considered the conditional probability of participation for each firm before program. We have done that by estimating a Probit model conditioned for variables given by productive sector, added value, employment and simple interactions among these variables[17]. The average results of this probability by group are shown in table 6.

[Table 6]

In general, the companies of the control group have `on the average' a probability of participating of 27%, this being a much lower value than the participating companies, which show a probability of 59%. Another form of investigating the differences between the two groups of companies before participating is by means of watching the empirical distribution of the probability of participating. The results are shown in Graph 1.

[16] Chi-Square of 4.2176 with a probability of 0.963.

[17] The Probit model has a (pseudo) R2 of 0.2967 and with a Chi-Square of 100.60 with probability 0.000. That is, both model are well different under a multivariate set up.

In sum, the control group companies have a very low probability of becoming Profo participants. In fact, there are relatively few firms of the control group with high probability of participating. This graph illustrates the problem referred to in the methodological discussion: the existence of large differences in the distribution of firms of the two groups. This implies the necessity of re-weighting the observations in the control group[18].

[Graph 1]

4.3 Estimates of Impact

The first two results of impact shown correspond to an estimate of the program effect on the growth of the TFP using the traditional approach of the `Before-After' estimator, and the alternative estimator `Differences in Differences'. To accomplish this, a Cobb-Douglas production function was assumed. In the first estimator we considered the production function specified in first differences *only for the group of participating firms*; the productivity results are captured in the constant of the model. In the second estimator we incorporate the control group into the database and we re-estimate the model. In this case the coefficient of the dummy variable is the impact estimator. Because we are estimating in first differences, we are implicitly controlling for heterogeneity within groups.

As indicated in Table 7, the Before - After estimator shows a growth in the TFP, after three years of participation in the program, of 22,9%. However, this result could be an overestimation of the real impact because it does not take into account that *without the Profo program* the TFP of these companies would have grown in natural way due, for example, to learning phenomenon and technological change. When controlling for these effects, the result was that growth in the TFP during participation was 11,7%. That is to say, the traditional estimator appears to overestimate the results by almost 100%.

[Table 7]

However, the previous results are conditioned by the presence of a control group and a sample of participants that does not necessarily have an identical distribution of attributes. In some way, this could affect the results. In order to correct for this problem, we also estimate the impact model by using observations whose propensity scores overlap. We call this estimator `the Differences in Differences with Common Support' estimator.

As we can observe in Table 8, the estimate using observations that are in this overlapping region of the propensity score improves the impact of the program slightly; it now increases to 14,4%. In the Graph 2, we see that if we truncate the propensity score distributions so that they are in the same support, the two are much more similar: However important deviations persist in the weightings of both distributions.

[Graph 2]

[18] Moreover, a Kolgomorov-Smirnov test of equal distributions was strongly rejected with a value of 0.4513 and a probability of 0.000.

[Table 8]

In Table 9, the results of the matching estimator are shown for three different values of h. The standard deviation of the estimators has been calculated based on the bootstrapping method with 100 replications of the sample. The results of the matching estimator show a growth of the productivity in the range of 14,9% to 12,4%. These results are statistically significant.

[Table 9]

A comparative analysis of the three estimators suggests that the estimator before-after omits the control group and strongly overestimates the impact of the instrument. However, the simple differences-in-differences estimator is the strictest and gives the smallest impact. When conditioned for the same support, the impact of the instruments rises to values of around 14%. The matching estimator, that re-weights the observations of the two groups gives results in the range of 12.4% to 14.9%.

In synthesis, whatever estimator incorporates a control group gives statistically significant evidence that the program has had a positive impact on the firms. If we use the Differences in Differences estimator conditioned for the same support, the growth of productivity would have been 14.4% after three years of participation in the program. This result suggests that the program has been effective. But the pertinent question is: Has it been efficient?

5 Cost- Benefit Analysis

The cost-benefit analysis determines what has been the gain generated by the program when it is applied to a certain level of effort φ , compared to the situation where there is no program and it no longer applies, that is φ =0. Then define the benefit of the program as:

$$\begin{aligned} B(\varphi) = &\{N_1(\varphi)\cdot E(Y_1 \mid D=1,\varphi) + N_0(\varphi)\cdot E\,(Y_0 \mid D=0,\varphi) - c(\varphi)\} \\ &-\{N_1(0)\cdot E(Y_1 \mid D=1,0) + N_0(0)\cdot E(Y_0 \mid D=0,0)\} \end{aligned} \tag{24}$$

where N_1 (φ) is the number of participants in the program when it is implemented at the level of effort φ. $N_0(\varphi)$ is the number of non-participants when the program is implemented at level of effort φ. *E* (Y_1 | D=1, φ) it is the average result of the participants when the program is implemented at level of effort φ. *E* (Y_0 | D=0, φ) is the average result for the non-participants when the program is implemented at level of effort φ and, finally, c(φ) it is the cost of the program associated with an established level of effort.

Then when φ =0 , as is in the state non-participation, $N_1(0)=0$ y $N_0(0)=N$, that is the population. Likewise, if B(φ)=0, then the total product is increased when the program is set at level φ . For the special case where the result in the benchmark state "0" is the same whether or not the program exists, in other words when:

$$E(Y_0 \mid D=0,\varphi) = E(Y_0 \mid D=0,0) \quad (25)$$

There are no general equilibrium effects and the state "without program" of the non-participants is similar to the non-participation state `with program'. This assumption allows us to generalise from the general equilibrium to the partial equilibrium. Keeping in mind that $N=N_1(\varphi)+N_0(\varphi)$, if condition (25) is true, we obtain:

$$B(\varphi) = \left\{N_1(\varphi) \cdot E\left(Y_1 - Y_0 \mid D=1,\varphi\right) - c(\varphi)\right\} \quad (26)$$

If it is assumed that a redistribution of benefits without costs is possible, maximisation on (φ) in the previous expression allows us to obtain the program effort level that maximises social welfare. For this important case, which is applied to social programs on a small scale with partial participation, the measurement of the program impact can be easily calculated. We only have to multiply the average impact obtained in the previous section by the number of participants and subtract the costs of the program.

For the PROFO participants interviewed we calculate the operation costs of the program. These were computed taking into account not only the CORFO contribution but also that of the participating companies. These are only direct costs, because they do not include the operation costs of the institutions involved such as Asexma, Sercotec and CORFO. Nor were the costs of other activities considered, such as those that were carried out during the program with extra funds such as `commercial missions', `training', etc. For these programs the values here presented correspond to a minimum estimate.

The benefits of the program generated an increase in value added of 14% above expected in the event of non-existence of the program. According to the previous results the average value added of the companies would have grown in US$ 39,200 due to the program. The total increase was US$ 4,037,600. These results give an estimation of an Internal Return Rate for the program of 21%. That in any event is larger than the economy social discount rate. The Present Value of the Program discounting the social discount rate is US$ 391,711.

[Table 10]

7 Conclusions

The evaluation of the Development Programs (PROFO), shows that the instrument can have a favourable impact on participating companies. As a result of the assistance received, companies have carried out modifications of importance in some of the productive and managerial practices, and these have been reflected in productivity improvements.

The results indicate that the main achievements have been concentrated mostly in three areas:

Improvements in the organisation and administration of firms (introduction of elements of planning, better specification of lists and functions, focus on the achievement of scale economies, and the incorporation of modern marketing strategies).

Improvements in the accumulation of human capital (greater access to managerial training and production employee training).

Improvements in the access to the Chilean National Extension System (fundamentally technological institutes, consultants, and supporting funds like the Technological Fund -Fontec - and the Fund for Technical Attendance -FAT -).

However, program results are smaller related to significant improvements in the innovation of products and processes.

The program has not only been effective, but has also been efficient in increasing the productivity of firms; the costs and resources invested in the operation of the program have been more than recovered.

In terms of methodology, it appears as a fundamental issue that the evaluation of program impact requires follow-up on the participating companies, as a way of building panel estimators such as the `differences in differences' estimator. However, a database of control companies is also necessary. To do this, it turns out being necessary to integrate the databases of various public institutions in order to provide a `non-experimental' control group.

Another alternative for the control groups is to design the instrument with the impact evaluation in mind. This could be integrated into the program in sequential form by, for example, overlapping the participants over time, providing the appropriate controls. Or to start the program in different geographical regions, and to match the companies of different regions by their similarities.

Finally, it is necessary to carry out a cost-benefit analysis of the program. However, if program coverage is very high, it will be necessary to introduce elements of general equilibrium to measure the return of the instrument.

8 References

Benavente, J.M., 1999, Development projects A Partnership experience in Chile, *SME Observer* Vol. 1 No. 1. Enterprise Research Institute. Washington D.C.

Benavente, J.M. and G. Crespi, 1996, The Chilean National System of Innovation, *Estudios de Economía* Vol. 23 No. 2. Universidad de Chile. Santiago.

Benavente, J.M. and G. Crespi, 1995, Una metodología para el estudio del esfuerzo innovativo de las empresas manufactureras chilenas, *Estadística y Economía* No. 11. Instituto Nacional de Estadísticas. Santiago.

Burtless, G., 1995, The Case for Randomized Field Trials in Economic and Policy Research, Journal of Economic Perspectives, Vol.9. Spring.

Calomiris, Ch. and G. Hubbard, 1988, Firm Heterogeneity, Internal Finance and Credit Rationing, Working Paper Nº2497. NBER.

Dehejia, R.H. and S. Wahba, 1998, Causal Effects in Non-Experimental Studies : Re-Evaluating the Evaluation if Training Programs, W*orking Paper Nº 6586.* NBER.

Fraker, T. And R. Maynard, 1983, Group Designs for Evaluating of Employment-Related Programs, The Journal of Human Resources...

Heckman, J., 1990, Varieties of Selection Bias, American Economic Review, 80, 313-318.

Heckman, J.; H. Ichimura; J. Smith and P. Todd, 1998, Characterizing Selection Bias Using Experimental Data, Econometrica, Vol 66, No 5 , 1107-1098.

Heckman, J.; R. Lalonde and J. Smith, 1998, The Economics and Econometrics of Active Labor Market Programs, in : O. Ashenfelter and D. Card (Editors) Handbook of Labor Economics, Volume III,

Montero, C., 1995, Metodología de Evaluación de Programas de Fomento (PROFO), mimeo, CIEPLAN. Santiago.

Oldsman, E., 1995, Do Manufacturing Extension Programs Matter?, in : Shapira, Ph and J,Youtie (Editors), Evaluating Industrial Modernization. Methods and Results in The Evaluation of Industrial Modernization Programs, Georgia Institute of Technology, School of Public Policy and Economic Development Institute.

Rosenbaum, P. and D. Rubin, 1983, The Central Role of the Propensity Score in Observational Studies for Causal Effects, Biometrika, Vol.70.

Rosenbaum, P. and D. Rubin, 1985, Reducing Bias in Observational Studies Using the Subclassification on the Propensity Score, Journal of the American Statistical Association, Vol.79.

Rubin, D., 1974, Estimating Causal Effects of Treatments in Randomized and NonRandomized Studies, Journal of Educational Psychology, Vol.66.

Rubin, D., 1977, Assignment to a Treatment Group on the Basis of a Covariate, Journal of Educational Statistics, Vol.2.

Rubin, D. 1978, Bayesian Inference for Causal Effects: The Role of Randomization, The Annals of Statistics, Vol.6.

Universidad de Chile, 1997, Evaluación del Instrumento PROFO, Final Report and Apendix, Department of Economics, Santiago.

Table 1: Relative Productivity Gap of a great firm in relation to a SME (%).

	1992	1993	1994
Productivity	44	47	42
Wages	51	53	52

Source: ENIA.

Table 2 : Innovations undertaken by firms; importance of PROFO in each.

	FIRMS WITH POSITIVE ANSWERS (1)	FIRMS THAT ANSWERED THAT THE PROFO WAS IMPORTANT (2)	RATE OF IMPACT (2)/(1)
Has the firm improved…			
The Organization?	64%	25%	0.39
Strategic Planning?	64%	32%	0.50
The Management?	46%	15%	0.33
Marketing Strategies?	69%	41%	0.59
Client satisfaction?	47%	18%	0.38
The definition of roles and responsibilities for the various positions of the organization?	79%	30%	0.38
The production mix?	77%	22%	0.29
Related to innovation of the production process, has the firm improved…			
Information technologies?	33%	16%	0.49
Planning of production?	41%	20%	0.49
Management of existences?	34%	18%	0.53
Distribution?	36%	16%	0.44
Automation?	41%	16%	0.39
Quality Control?	47%	22%	0.47
Lay-out?	39%	13%	0.33
Outsourcing?	20%	9%	0.45
Vertical Integration?	33%	12%	0.36
Safety in the production?	45%	17%	0.38
Environmental conditions?	30%	7%	0.23
External standardization of quality process?	23%	10%	0.44
Has the firm collected of information related to production processes?	34%	34%	1.00
Related to innovation of products, has the firm introduced…			
New Products?	53%	18%	0.34
Improvement s in products?	62%	25%	0.40
Improvements in product design and packaging?	51%	19%	0.37
Related to the management of human resources, has the firm introduced…			
Training of workers?	38%	28%	0.74
Training of employees?	37%	24%	0.65
Training of managers?	62%	48%	0.77
Evaluation of training needs?	39%	19%	0.48
New incentive procedures for employees?	34%	7%	0.21
Reduction of rotating?	29%	5%	0.17
More participation for workers in issues related to the quality process?	40%	15%	0.37
Related to the external relationships of the business, has the firm improved…			

The ability to negotiate with the clients?	63%	30%	0.47
The ability to negotiate with suppliers?	52%	19%	0.36
The capability to get new suppliers?	41%	16%	0.39
Enlarged national coverage?	45%	21%	0.46
Enlarged international coverage?	38%	21%	0.55
Business contacts with other managers of Profo?	65%	53%	0.82
Business contacts with other managers outside of Profo?	35%	17%	0.48
Participation in sector associations of producers?	31%	20%	0.65
The capacity to access public support instruments?	56%	41%	0.73
Has there been innovation in the external relationships- related Technological environment…			
Public institutions ?	32%	23%	0.72
Clients?	47%	12%	0.28
Suppliers?	30%	5%	0.14
PROFO Managers ?	41%	27%	0.66
Competitors?	24%	6%	0.25
Universities?	17%	9%	0.53
NGOs ?	14%	8%	0.57
Private consultants ?	31%	19%	0.61
Regarding the external relationships related with Financial aspects has there been innovation in…			
Capacity for formulating investment projects?	47%	26%	0.60
Access to private banking credit ?	47%	12%	0.25
Access to institutional resources ?	50%	32%	0.64

Table 3: Distribution of the participant and control firms by productive sector (number of firms, percentage between the groups and percentage between sectors).

CIIU	Treated	Control	Total
Beverages	10 45.45 6.76	12 54.55 11.76	22 100.00 8.80
Textiles	17 60.71 11.49	11 39.29 10.78	28 100.00 11.20
Wearing Apparel	7 58.33 4.73	5 41.67 4.90	12 100.00 4.80
Wood Products	24 61.54 16.22	15 38.46 14.71	39 100.00 15.60
Furniture	17 60.71 11.49	11 39.29 10.78	28 100.00 11.20
Rubber Products	9 69.23 6.08	4 30.77 3.92	13 100.00 0.40
Plastics Products	0 0.00 0.00	1 100.00 0.98	1 100.00 0.40
Iron and Steel	6 54.55 4.05	5 45.45 4.90	11 100.00 4.40
Metal Products	12 60.00 8.11	8 40.00 7.84	20 100.00 8.00
Mechanical Machinery	38 61.29 25.68	24 38.71 23.53	62 100.00 24.80
Electrical Machinery	2 50.00 1.35	2 50.00 1.96	4 100.00 1.60
Transport Equipment	6 60.00 4.05	4 40.00 3.92	10 100.00 4.00
TOTAL	148 59.20 100.00	102 40.80 100.00	250 100.00 100.00

Table 4: Average Added Value of Participating and Control Firms (in thousands of $Chilean of 1992).

Group	Obs	Mean	Standard Error	t-student
Control	149	333148,7	80509,0	
Treated	102	112130,6	21368,1	
Difference		221018,1	95513,4	2,314
Probability				0,0257

Table 5: Average Employees of Participating and Control Firms (by number of workers in 1992).

Group	Obs	Mean	Standard Error	t-student
Control	149	39,23	2,40	
Treated	102	24,91	3,03	
Difference		14,32	1,93	3,7406
Probability				0,0002

Table 6: Average Probability of Participating by Group (1992).

Group	Obs	Media	Standard Error	t-student
Control	149	0,2796	0,0187	
Treated	102	0,5947	0,0232	
Difference		-0,3150	0,0297	-10,5974
Probability				0,0000

Table 7: Average Growth in TFP.

Statistics	Before-After Estimator	Difference in Difference Estimator
Mean	0,2295	0,1177
Standard Error	0,0512	0,0600
t-student	4,4830	1,9610
Probability	0,0000	0,0510

Table 8: Average Growth in TFP.

Statistics	Before-After Estimator	Difference in Differences Estimator	Difference in Differences Estimator Common Support
Mean	0,2295	0,1177	0,1442
Standard Error.	0,0512	0,0600	0,0650
t-student	4,483	1,961	2,217
Probability	0,000	0,051	0,028
Observations	102	252	174

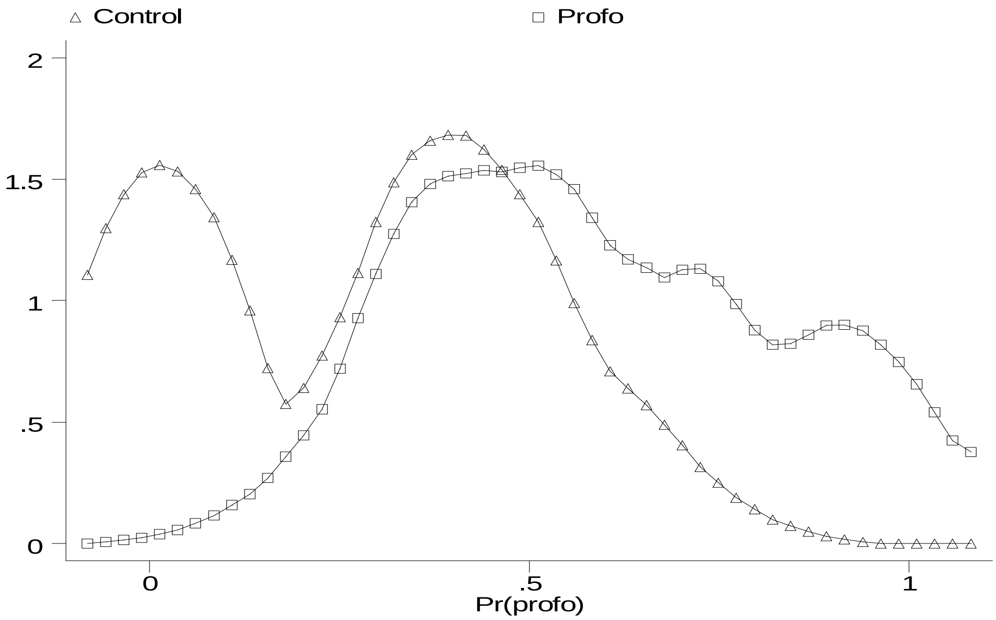
Table 9: Average Growth in TFP.

Statistics	Before-After Estimator	Differences in Differences Estimator	Diff in Diff Matching Estimator H: 0.2	Dif in Dif Matching Estimator H: 0.3	Dif in Dif Matching Estimator H: 0.4
Mean	0,2295	0,1177	0,1490	0,1318	0,1246
Standard Error.	0,0512	0,0600	0,0722	0,0678	0,0650
t-student	4,483	1,961	1,936	1,993	1,994
Probability	0,000	0,051	0,055	0,048	0,048
Observations	102	252	171	171	171

Table 10: Cost-Benefit Balance (US$ of 1995).

Rubro de Costos	U$S
Resources from Corfo	1.562.590
Resources from Firms	1.022.013
Other Resources	117.542
Total Costs	2.937.215
Gains from higher Productivity	4.037.600
Difference	1.100.385
NPV	391.771
IRR	21%

Graph 1: Propensity Scores for Participation in the PROFO Program. Beneficiary Firms and Control Group.



Graph 2: Propensity Scores of Participating in the PROFO Program.
Beneficiary Companies and Control with Common Support.