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Roberto Alvarez
Gustavo Crespi
Conrado Cuevas

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Roberto Alvarez
robalvar@fen.uchile.cl
Department of Economics and INTELIS, University of Chile

Gustavo Crespi
gcrespi@iadb.org
Inter-American Development Bank

Conrado Cuevas
conrado.cuevas@gmail.com
INTELIS, University of Chile

Abstract

This paper evaluates the impact of two public programs, FONTEC and FONDEF, aimed at fostering innovation in Chilean firms. With the cooperation of several public agencies, participants and non-participants in these programs during the period 1995–2000 were identified from a large panel of firms in the manufacturing sector. From this information, the effect of the programs could be determined using propensity score matching (PSM) and differences in differences (DID) in a multiple treatment setting. Results show that these programs have generally been associated with increases in employment and productivity, but the impact is heterogeneous across programs and indicators of firm performance.

JEL codes: D22, L2, O3
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1. Introduction

There is broad consensus that innovation is an important source of productivity growth and that it can explain why some countries get richer and others fall behind. Under this assumption and given that market failures do not allow countries to reach optimal levels of innovation, most countries around the world have implemented fiscal incentive programs to improve private sector innovation and productivity.[1] In Chile, since the mid–1990s, successive governments have promoted business innovation policies oriented to improving long-run productivity and economic growth. Although there is some evidence that fiscal incentives encourage firm-level investments in innovation, the impact of these public policy programs on firm performance in developing countries in general, and in Chile in particular, has not been fully evaluated.[2]

A few specific programs in Chile have been analyzed. An early attempt to evaluate a public policy program was carried out by Benavente and Crespi (2003), who looked at the effects of PROFO (Group Development Projects) on firm performance. However, this program is not directly linked to the improvement of innovation outcomes. The PROFO Program was designed to overcome scale barriers that could impede access of small and medium-sized enterprises (SMEs) to technology, markets, and management skills by providing incentives for firms to voluntarily come together to address a common set of production or management problems (Tan, 2009).

Benavente et al. (2007) evaluated the FONTEC program using a survey specially designed for a sample of treated and untreated firms. The treated firms correspond to those

[1] Fiscal incentives come in two forms: direct subsidies and tax incentives. In the case of Chile, the bulk of the fiscal incentives system has been based on direct subsidies. Recently, Chile began exploring tax incentives.
[2] For a review of the evidence for some programs and countries in Latin America, see Hall and Maffioli (2008) and Lopez-Acevedo and Tan (2010).

funded by Line 1 during the period 1992–2002.[3] The results suggest a positive effect of this program in terms of input additionality. It increased the overall R&D budget of the firms, but it did not stimulate additional private investment in innovation activities (the crowding-in effect). They also found that FONTEC effectively promoted process innovation and fostered changes in the innovation strategy of the firms, but it did not significantly foster patenting activities and had no significant impact on the creation or adoption of new products. In terms of firm performance, they found that FONTEC increased sales, employment, and exports, but did not significantly affect productivity. However, one problem with the methodology used in this paper is that because the information on firm performance was collected through a dedicated survey, it is subject to recall bias. Another problem is that firms were followed over fixed period of three years from the innovation project's inception, leading to results that have validity only for the short term.

Tan (2009) used a specific question on the World Bank's Investment Climate Survey to identify firms that had made use of different productive development programs offered by the Chilean Development Agency (CORFO). After identifying both treated and untreated firms, he linked the results to the Annual Survey of Manufacturers in order to evaluate the various programs offered by CORFO. He found evidence that participation in these programs is associated with improvements in intermediate outcomes (training, adoption of new technology, and organizational practices). He also found statistically significant effects of these programs on sales, production, labor productivity, wages, and exports. Interestingly, the

[3] FONTEC operates five lines. Line 1 corresponds to projects aimed at developing new products and improving production process. The other four financing lines cover technological infrastructure, group technological transfer, technology transfers organizations, and pre-investment studies. For more details, see Benavente et al. (2007).

findings reveal positive effects for subsidized technical assistance programs, and support for cluster formation and technology upgrading, but not for financing programs.

One problem with Tan's (2009) methodology is that beneficiaries are identified from self-reported information provided by the firms. This introduces an unknown bias to the estimates due to measurement error with regard to the treatment variable. Moreover, although firms are followed over a longer period of time, findings are only valid for the cross-section of firms that actually answered affirmatively to the enterprise survey, and there is no way to guarantee that the findings can be also extrapolated to other cohorts of beneficiaries.

There are other recent program evaluations for Chilean instruments, but they are not directly focused on innovation. Bonilla and Cancino (2011) measure the impact of the Seed Capital Program of SERCOTEC, a program attempting to reduce the problem of financial access for small firms. The results show a positive and significant effect on employment, but not on sales. Arráiz, Henríquez, and Stucchi (2011) evaluated the impact of the Chilean Supplier Development Program, which is aimed at improving and stabilizing commercial linkages between SMEs suppliers and their large-firm clients. The results show a positive effect of this program on employment, sales, and the sustainability of the SMEs suppliers.

More recently, the SMEs division of CORFO carried out a full impact evaluation of the different programs aimed at productivity upgrading by SMEs (CORFO, 2010). The findings suggest that programs that provide technical assistance (such as the Technical Assistance Fund-FAT) and even the PROFO program had no impact on firm performance. This was not the case with regard to cluster and supplier development programs, where the results were encouraging. A notable feature of this evaluation is that it makes use of tax registry information, which allows for the identification of almost all the beneficiaries and for access to a large group of potential control firms. However, this same virtue is also a problem, as the information contained in the tax register on firm characteristics is very limited, which makes it of little use in identifying a comparable group of control firms. Another methodological problem with this evaluation is that it follows beneficiaries over a very short period of time—two years on average—so the results are only valid for the short term.

This paper evaluates the impact of two public programs aimed at increasing innovation in Chilean firms. In contrast to previous evidence, we use a large panel of plants in the manufacturing industry during the period 1995–2006. We do not have to rely on special surveys that might not be representative and are affected by recall bias. With the cooperation of the Chilean National Research Council (CONICYT) and CORFO, we identified firms that have participated in these programs. In collaboration with the National Office of Statistics (INE), we linked this information to the national annual manufacturing survey (ENIA), which yielded a large group of potential control firms. This information allows us to identify the effect of the programs using propensity score matching (PSM) and differences in differences (DID). Moreover, since there is a small overlap in the beneficiaries of the two programs, we were able to apply a multiple-treatment methodology and determine whether both programs have reinforcing effects.

Our results show that these programs are associated with both employment and productivity growth, but that the impacts are heterogeneous not only across programs and but also according to the indicator of firm performance. In addition, the evidence points to an important reinforcing effect of using both programs. However, this finding needs to be evaluated taking into account that the sample of multiple users is very small.

This paper is structured as follows. The next section discusses the rationality for government intervention with regard to the business innovation. The third sections describes the main features of the assessed programs. The fourth section presents the data and the main findings on program utilization. The fifth section presents the methodology. The sixth section provides the results of the programs evaluation using several specifications. The seventh section concludes.

2. The Rationale for Innovation Policy

The fundamental premise underlying innovation policies is that government intervention would be necessary if profit-driven actors underperformed with regard to the production and/or exchange of technological knowledge from a social welfare perspective (Steinmueller, 2010). The economics of innovation literature has provided several rationales justifying that this is indeed the case. Broadly speaking, the rationale for public policy in this field can be articulated around the following considerations:

(i) Spillovers and the "public good" nature of knowledge

Since the seminal works by Nelson (1959) and Arrow (1962), scientific and technological knowledge has been regarded as a nonexcludable and nonrival good. To the extent that private benefits associated with knowledge creation are not fully appropriable by the innovators, this creates a wedge between the private and social returns of knowledge investments, leading to a rate of investment in knowledge that will fall short of socially optimum levels. This rationale applies not only to the *levels* of innovation efforts but also to the *direction* of these efforts. Certainly, the "public good" rationale of knowledge applies more strongly to *scientific* than *technological* knowledge.[4] To the extent that the latter is more applied, predictable, and linked to firm-specific assets, it is more likely that innovators will be able to collect a larger share of the value of innovation to society, so that private sector investments in technological knowledge would be closer—although not equal—to socially optimal levels.[5]

(ii) The problem of asymmetric information

The economics of information literature (Stiglitz and Weiss, 1981) makes clear that asymmetric information in market transactions (due to the problems of adverse selection and moral hazard) can affect firm innovation from two different perspectives. From the perspective of investment theory, innovation projects have several peculiar characteristics, which differentiate it from ordinary investment (Hall and Lerner, 2010). First, innovation projects are riskier than physical investment projects. Consequently, external investors might require a higher risk premium for the financing of innovation activities. Second, because of the problem of spillovers, innovators are reluctant to share information about their projects with potential outside investors, further worsening the asymmetric information problem. Third, the difficulty of using intangible assets as collateral also leads to increased costs for external capital in the form of a higher risk premium. In summary, asymmetric information creates a wedge between the opportunity cost that private innovators require for their innovation investments and the cost of capital that external investors are willing to charge to

[4] On the other hand, projects with a significant basic research component are unlikely to produce results with commercial application in the short run. Although this may discourage private investment, the projects could still have a high social return because of the skills and knowledge produced during their development, apart from their final achievements.

[5] The applied nature of technological knowledge also makes it more prone to being protected by intellectual property rights. However, this by no means implies that firm investment in technological knowledge will be socially optimal; appropriability problems also exist in the case of this knowledge, as the coverage offered by intellectual property rights protection is usually limited.

finance innovation projects. The result is that privately (and eventually socially) profitable innovation projects will not materialize because the cost of financing is simply too high.

The second perspective on how asymmetric information affects innovation concerns knowledge dissemination, and it relates to the fact that private actors do not have perfect information on technology or production possibilities. Adverse selection and moral hazard problems also extend to the (imperfect) operation of technology markets. This claim is consistent with two empirical findings: (i) that there are persistent differences in the technological performance between countries, so that catching up is far from being an automatic process, consistent with the idea of knowledge as a global public good (Fagerberg and Verspagen, 2002); and (ii) that the process of technology diffusion, even within narrowly defined industries, is sluggish, leading to a persistent firm heterogeneity in productive performance (Disney, Haskel, and Heden, 2003).

(iii) The pervasiveness of coordination and institutional failures

A key contribution of the innovation systems literature is that knowledge has non-negligible tacit components and as such innovation is the result of feedback and interaction involving numerous actors (Lundvall, 1992). Although many of these interactions are market mediated, a large proportion of them are governed by nonmarket institutions. Because the efficiency of this process at the macro level depends on the behavior of individual actors and the institutions that govern their interaction, coordination problems might arise (Soete, Verspagen, and Ter Weel, 2010). Solving the coordination problem requires paying attention not only to the linkages among the actors but also to their absorptive capacity (Cohen and Levinthal, 1989). The concept of absorptive capacity is a key ingredient of the new literature of innovation, in particular from the perspective of catching-up economies. Following

Steinmueller (2010), the concept of absorptive capacity refers to fact that new knowledge might not be employable without heavy co-investments by the users in corresponding human capital and learning; furthermore, it implies that the new knowledge might not be reproducible without the direct assistance of the originator.

To the extent that institutions govern human interactions, the innovation systems literature puts strong emphasis on institutional governance and change. These are institutional design arrangements that foster public-private interactions while minimizing problems of moral hazard. Institutional change interventions build linkages between the different actors involved in the innovation process (universities, public research organizations, technology producers and users, consumers, etc.) either by defining new roles for existing institutions (such as allowing the patenting of university research in order to encourage technology transfer) or by creating clubs or consortia that regulate interactions between the agents (Steinmueller, 2010). These sorts of arrangements may lead to a better equilibrium because innovation costs are not duplicated in separate efforts that lead to identical results, several externalities are internalized, and access to complementary tacit knowledge is encouraged.

3. The Implementation of Innovation Policy: The Case of Chile

The previous analysis offers different conceptual frameworks that justify the implementation of innovation policies based on the idea that profit-seeking agents will produce both a level and direction of knowledge investments that will fall short of socially desirable outcomes. According to David, Hall, and Toole (2000), broadly speaking, public policy has suggested two main approaches to solving the under-provision of innovation efforts by private firms: (i) direct production of knowledge in public institutions (universities, laboratories, and public research institutes); and (ii) fiscal incentives for a greater amount of private investment in knowledge generation. Without ignoring the importance of government investment in public research organizations, the issues of governance, funding incentives, and productivity impacts related to the operations of these organizations are sufficiently complex as to require a far more specific focus than the scope of this paper allows. The focus herein is on a particular class of fiscal incentives: direct subsidies, without ignoring that there are other available types of fiscal incentives, such as tax incentives and entrepreneurship programs, among others. However, coverage and implementation experience in the case of Chile is far more limited.

Since the early 1990s, the Chilean government, through diverse public agencies, has implemented several programs designed to support innovation and productivity in private firms. This paper focuses on two such programs, FONTEC and FONDEF.

FONTEC (National Productivity and Technological Development Fund), managed by the Chilean National Development Agency (CORFO), provides financing for innovation projects carried out by private firms. FONTEC was established in 1991 and has supported more than 2,200 business innovation projects. FONTEC operates as a matching grant, subsidizing a percentage of the total costs of the private projects, the private co-funding has varied between 40 and 65 percent, and it has increased over time (Benavente, Crespi, and Maffioli, 2007). The subsidy never covers the full costs of the supported project, allowing for better alignment between the goals of the public agency and the firm, somehow controlling for the potential problem of moral hazard. In other words, if the beneficiary wants to increase the size of the innovation project in order to extract a higher subsidy, it will have to pay more. Related to this, a noteworthy feature of this cost-shared approach is that public agencies can also adjust the amount of the co-funding according to the main characteristics of the projects or the beneficiary. Indeed, in the case of innovation projects, the share of the subsidy might increase when the project implies the participation of more than one beneficiary since it is expected that projects that involve more than one firm or a firm collaborating with a university might lead to higher spillovers.

Sometimes subsidies might target the fixed capital component of an innovation project (for example, the R&D laboratory or the CAD system) under the assumption that when these capabilities are available they might reduce the innovation costs of future innovation projects. Alternatively, there might be an increase in the subsidy component when the project's beneficiary is a small firm, under the assumption that the intensity of market failures faced by SMEs is also higher. Finally, the operation of the co-funding mechanisms is implemented through the ex-post reimbursement of the approved expenditures that qualify for the subsidy.

Box 1 provides the main objectives of these programs and a description of the financing lines. The focus of evaluation is on the impact of the Line 1, which is the utilization of direct subsidies oriented to business innovation. This line only finances innovation projects carried-out by individual firms. The Line 1 represents the backbone of FONTEC, with more than 70 percent of the total number of supported projects and almost 80 percent of total funding (between 1992 and 2004). The remaining lines described in the box had much lower activity.

An important attribute of FONTEC is that grants are allocated under an open window system on a first in-first out basis. External peer reviewers technically assess innovation projects submitted by firms, and an adjudicatory committee with representatives from both the public and private sectors makes the decision. The rationale for the open window system rests on the idea that business innovation support requires flexible and fast assessment mechanisms, goals that are more difficult to achieve in the case of a system based on calls for proposals. Although this approach provides for a more flexible system, the main drawback is that the competition component normally associated with a call for proposal system might be somehow mitigated.

It is clear from Box 1 that the main objective of Line 1 of FONTEC is to provide for a better alignment between internal and external costs of financing innovation projects, providing a signal to both firms and financiers that they should become involved in innovation. Thus, it would appear that Line 1 is targeting an asymmetric information problem and the typical liquidity constraints that hinder business innovation.

In March 2005, FONTEC was formally terminated and merged with another fund (known as the Innovation Development Fund—FDI), giving rise to a new organizational structure called INNOVA. The merger was motivated not only by the need to increase the operational efficiency of both funds and avoid duplication of effort, but also by the need to create an organization capable of implementing programs with a sector focus in addition to the standard “open window” system. Despite this, many of the lines of FONTEC, and in particular Line 1 (renamed “business innovation”), remained in operation under INNOVA. However, because in 2006 INNOVA put in place new programs to support the generation of sector public goods, entrepreneurship, and technology transfer and diffusion, the share of Line 1 in the overall budget of INNOVA declined to about 25 percent.

FONDEF (Science and Technology Development Fund), managed by CONICYT, provides funding for precompetitive R&D and technology projects organized jointly by universities, technology institutes, and the private sector. The government's subsidy also corresponds to a matching grant covering part of the total costs of the project (Tan, 2009). The objective of this program is to contribute to improving the competitiveness of the national economy through joint projects between research institutions and private companies to carry out applied research, precompetitive development, and technology transfer.

The financing is directed at universities and nonprofit research and development institutions, as main beneficiaries, but private sector participation is required. A main difference between FONDEF and FONTEC is that the allocation of the research and development grants is carried out through an annual public bidding process based on project proposals, although an open window system operates for the financing of technology transfer projects. The maximum contribution of FONDEF is 55 percent of the total cost of the project with a maximum of approximately US$900,000 for projects with a duration of 36 months. The research institution (executor) involved in the project is required to contribute an amount equivalent to 20 percent of the total cost of the project. For associates and companies, the required minimum contribution is 25 percent of the total cost of the project. For those projects requiring more time to be executed (up to 72 months), there is a maximum amount of about US$1.5 million financed by FONDEF.[6]

For FONDEF, the economic justification seems to be more closely related to the idea of subsidizing coordination failures and internalizing innovation spillovers through the formation of joint ventures and collaboration. In other words, in addition to providing cash financing, its objective was to create incentives for aligning the interests of public research organizations with those of the productive sector. These incentives would also allow

[6] The contribution of private agents can also be nonfinancial resources, such as hours worked by firm staff, facilities, and others.

companies to obtain access to a large set of complementary knowledge assets and technological infrastructure to implement their innovation programs.

Because tacit knowledge is not easily transmissible among multiple economic agents, the strengthening of innovation requires government-sponsored incentives for the establishment of formal agreements among the different organizations that are part of the innovation system. These joint projects between research institutions and firms would facilitate communication and exchange of information between suppliers and users of new technologies.

In sum, although FONDEF and FONTEC, by co-financing private initiatives, have the primary objective of improving innovation capabilities and productivity at the firm level, they aim at achieving this through very different mechanisms. While FONTEC focuses on alleviating the financial constraints that harm business innovation, FONDEF alleviates coordination failures that hinder collaboration and interaction between public research organizations and firms. Given the different nature of these two programs, it is important for policy design not only to compare them in terms of their impacts on business performance, but also to determine whether there are synergistic effects that would suggest the need for better coordination between the two programs. Before moving to the impact evaluation methodology, the next section describes the data used for evaluation in more detail.

Box1: Objectives of FONTEC and Financing Lines

The main objectives of this program are:

i. "to promote Research and Development (R&D), scientific technical services and other activities that contribute to technological development and thereby help enhance the ability of private business to compete and increase their output;
ii. to expand the national technology supply and use of technology either generated or adapted in Chile"; and
iii. to promote interaction and cooperation between the country's public research organizations and its businesses encouraging them to undertake joint projects"

FONTEC operates five financing lines:

Line 1 - Technological innovation: it finances projects aimed at developing new products and improving production processes. It covers the development of prototypes and market testing. The FONTEC subsidy cannot exceed 50 percent of total costs.

Line 2 - Technological infrastructure: it finances investment in physical infrastructure, installation, equipment and the training of staff involved in the development of this infrastructure. The co-financing limit ranges between 20 percent and 30 percent, depending on whether the investment is submitted by a single firm or a group of firms.

Line 3 - Group transfer: it supports projects submitted by a group of at least five firms and it covers the cost of technological missions abroad, training, and technical assistance held by highly specialized international experts. The co-financing limit is fixed at 45 percent for technological missions and 50 percent for specialized consultants. In any case the amount of funds granted by FONTEC cannot be higher than US$100,000.

Line 4 - Technology transfer organizations: it finances projects submitted by groups of at least five firms with the aim of setting up a technology transfer center to study, develop, disseminate, and adapt technology. The maximum subsidy is equal to 50 percent of the investment and cannot be higher than US$400,000.

Line 5 - Preinvestment studies: it supports evaluations and studies of potential technological investment. Maximum financing cannot exceed 50 percent of the overall cost or US$15,000.

4. Data

The dataset used in this paper is a combination of two main sources of information: The Annual Survey of Manufacturers (ENIA) and data on firms participating in FONTEC and FONDEF during the period 1995–2006. Although information on program participation is available for a longer time period, at the time of this evaluation the manufacturing survey (ENIA) carried out by the National Institute of Statistics of Chile (INE) was available only for the period 1995–2006.

This survey covers all Chilean manufacturing plants with 10 or more workers. For each plant and year, ENIA collects data on production, value added, sales, employment, and wages (production and nonproduction), exports, investment, depreciation, energy usage, foreign licenses, and other plant characteristics. In addition, plants are classified according to the International Standard Industrial Classification (ISIC) rev. 2. The fact that we are using ENIA as our business register implies that we are only able to assess the programs' impacts on manufacturing firms. According to information from program records, a little over 50 percent of the beneficiaries are manufacturing firms, with agriculture being the second largest sector (about 20 percent of beneficiaries) (Benavente and Price, 2009).

In contrast to ENIA, where information is recorded at the plant level, the information on participation in public programs is provided at the firm level, and a firm can have more than one plant. In such a case, the INE carried out a procedure for matching firm-level with the plant-level information. We have information for treated plants only, distinguishing between those belonging to a multi-plant and those that are one-plant firms. The empirical part of this paper assumes that all plants belonging to a firm participating in this program are treated.[7]

[7] Other allocation algorithms are also possible. For example, projects could have been allocated to the largest plant in the firm or to the lowest plant in the firm. Also, we could drop multi-plant firms. However, given the

The descriptive statistics show that a few plants have been beneficiaries of business innovation support programs. Table 1 shows the number of plants, the percentage over the total number of plants, and the accumulated percentage for each year during the period 1995–2006. On average, approximately 50 plants per year have participated in these programs, representing less than 1 percent of the total number of plants. In the case of plants using both programs, the number of participants is even lower, reaching a maximum of 8 plants in 2003, only 0.15 percent of the total number of manufacturing plants. However, by the end of the period, approximately 10 percent of the plants in the manufacturing industry had participated in FONTEC or FONDEF, and 0.75 percent of then had used both instruments jointly.

Table 2 show the distribution of participating plants across 2-digit industries for the period 1995–2006. The highest rate of participation in FONTEC corresponds to plants in the chemicals (35) and basic metals industries (37). In the case of FONDEF, the utilization of this program is higher for basic metals industries (37) and food, beverage, and tobacco industries (31). For firms using both instruments, those that used them the most were the chemicals industries.

5. Methodology

5.1 Evaluation Issues

The impact of two different programs on several measures of firm performance was evaluated using a quasi-experimental approach. Although innovation policies might be justified by the presence of market, coordination, and institutional failures, successful implementation needs to take into account the government's ability to deliver solutions. In

arbitrariness of the first choice and the loss of too many observations in the second (about 40 percent of treated plants belong to a multi-plants firm) prevent us of using these alternatives.

real life, governments face informational constraints that may be as or even more severe than those of firms. Firms, R&D projects, and innovations are highly heterogeneous. This means that policy that is optimal in the strict sense of achieving Pareto efficiency should vary not only from firm to firm, but also from project to project. This puts administrating agencies under a severe informational stress (Toivanen, 2009). Although there might be a strong case for STI policies, actual implementation could easily lead to the wrong results. In other words, public support could lead to the crowding out of private efforts.

According to Lach (2002), firms normally have a portfolio composed of several innovation projects. Under a matching-grant system, from the firm's point of view, receiving a subsidy may turn an unprofitable project into a profitable one or, alternatively, it may accelerate completion of a project already underway. If subsidies involve the setting up or upgrading of research facilities, the fixed costs of future research projects will be reduced, increasing the probability that they will be completed or undertaken. The know-how gained from the project being supported can spill over to other current and future research projects, thereby enhancing their prospects for success. In all these ways, a matching-grant subsidy may stimulate current and future research projects. If these hypotheses are true, a crowding-in effect of public financing on private innovation investment can be expected.

However, it is also possible to expect that some research projects would have been carried out in the absence of government funding anyway. There are several external sources of funds for research projects, including public, foreign, or multilateral institutions; the financial sector; and foundations. This possibility of substitution can be increased by administrators who are often under pressure to avoid the appearance of "wasting" public funds and who may be eager to fund projects with a higher probability of success and with clearly identifiable results (projects that are also likely to have access to a range of alternative sources of funding). Another reason for substitution is that a project enhanced by a subsidy could have an effect on the price of inelastically supplied complementary inputs (for example, research time). If the subsidy turns an unattractive project into an attractive one, but there are human capital constraints, the researcher or the team may decide to discontinue what previously was an attractive project (which might have been funded by other sources). The commitment to undertake the subsidized project may crowd out other unsubsidized projects (and their accompanying resources). Thus, it is not possible to simply extrapolate that increasing the firm innovation budget with public funds will lead immediately to a proportional increase in projects and to better economic performance.

One of the first issues to be defined in impact evaluation is how and when to measure the effects of the program, that is, the outcomes of interest. In the spirit of the CDM model (Crépon, Duguet, and Mairesse, 1998), a distinction can be made between innovation-input indicators and economic-performance indicators. Innovation-input indicators are those most directly affected by the intervention. For instance, for a fiscal incentives program, an innovation-input indicator is total investment in innovation by the beneficiary. While the relationship between the subsidy and the total investment seems in principle almost tautological, the previous discussion herein clearly highlights that this is not necessarily true (see e.g. David, Hall, and Toole, 2000). In other words, to the extent that innovation policies are able to change the firm's marginal cost of capital and to the extent that investment decisions react to this change in the cost of capital, it might be possible to identify the extent to which innovation policies generate *input additionality*.

However, just assessing whether innovation efforts increase as a consequence of a subsidy is not enough for policy evaluation purposes. The whole portfolio of innovation projects held by the firm is normally affected. As a result, projects with different levels of productivity might be executed while others might be postponed. Thus, assessing the outputs of innovation investments is critical (*output additionality)*.

Innovation outputs are variables where the concrete realization of innovation activities is observed and their impacts on economic performance materialize. In the case of business innovation programs, important output variables to measure *output additionality* are, for example, productivity growth, employment, wages, and exports to just cite a few. The standard approach in impact evaluation of innovation policies to date has been to focus on input additionality or, in other words, to look at effects on innovation investments, including R&D. This is done mainly because, due to data constraints, evaluators can follow beneficiaries over a short period of time after receiving the grant. However, if this period is too short, the only impact that can be truly measured is effort. This paper, however, moves away from this constraint. The dataset herein is rich enough to enable us to follow firms for a longer time period. Since the input additionality of FONTEC has already been tested (Benavente, Crespi, and Maffioli 2007), the focus of this research will be on the far more elusive output additionality.

Having beneficiaries' time series is important because, in the case of output additionality, a "time to build" period is normally necessary in order to determine impacts. More generally, the impact of different programs may display different patterns over time. An intervention may generate a one-shot increase in the outcome that could be either persistent or fade out progressively with time; the impact of a program may only appear after a certain period, or may even generate an initial drop in the outcome that is later overshot by increases in subsequent years. As a result, a proper consideration of the timing of the effects is crucial in an impact evaluation setting, and failures to account for these factors may lead to misleading conclusions and policy recommendations. Even after carefully considering and selecting the relevant outcomes and indicators, evaluating the impacts of public programs is not a trivial task, especially when the interpretation of the relationship between program participation and the outcomes of interest is to be causal.

In impact evaluation, the main definition of causality is based on the concept of *counterfactuals*. For instance, suppose a firm receives a subsidy for innovation investment, and suppose we observe the value of a given outcome of interest for that firm. Then, the public subsidy is said to have a causal effect if the outcome of the firm in absence of subsidy, but holding everything else equal, would have been different. In other words, the program or "treatment" has a causal effect if the observed outcome when the firm receives a subsidy is different from the counterfactual outcome, that is, the outcome that would have been observed if the firm had not received the subsidy. While this definition of causality is relatively simple and intuitive, it introduces a serious problem from an empirical point of view, because the counterfactual outcome, by definition, is never observed. In other words, if a firm receives a subsidy, it is impossible to know with certainty how this firm would have done it without it. This problem can be approached by setting a control group of firms that did not receive support from the program (or from any other program) selected in a way as to minimize all the observable differences between both groups.

5.2 Econometric Methodology

The major challenge in impact evaluation is how to properly set the control group in a way that renders a credible counterfactual. In any quasi-experimental impact evaluation, the key issue is how to minimize the selection bias that emerges from both the observable and unobservable differences between the control group and the beneficiaries in a no-treatment state. Although the differences between the two groups cannot be tested during the period over which the treatment is being implemented, it can be tested during the baseline period just prior to the treatment. The empirical strategy followed in this paper uses propensity score matching techniques in order to compare firms that are comparable where the propensity score is estimated on the basis of firm characteristics just prior to the treatment (characteristics both in level and in growth rates). After estimating the propensity score for each firm, control firms that fall outside the common support for the treated firms are eliminated from the sample. This eliminates firms in the control group that are very different from treated firms.

Using propensity score matching techniques allows for the reduction of the selection bias generated by differences in the observable characteristics of the firms in the different groups. However, it does not control for the selection bias generated by unobservable characteristics. In order to control for these characteristics, some assumptions need to be made. This paper uses the standard assumption that unobservable firm characteristics can be approximated by a plant-level fixed effect. This makes it possible to remove unobserved differences between the beneficiary and the control group by using either first differences or fixed-effect estimators, under the assumption that these differences are constant over time (see Hall and Maffioli, 2008). After identifying comparable firms using the propensity score estimates, fixed effects panel data techniques are used to estimate the impacts using the selected sample of firms.

Given that in this research we have two interventions (or three treatments), the empirical strategy summarized above needs to be adjusted. In this case, the treatment variable can take four values, i.e. T=j with j=(0,1,2,3). The treatment is codified as follows: 0 when the firm receives no treatment, 1 when the firm participated in FONTEC only, 2 when the firm participated in FONDEF only and 3 when the firm participated in both.

Let P_i be the probability of receiving the treatment T=j. To estimate this probability, we use a Probit model with j=0 as the base category. To evaluate these programs, we estimate pair-wise Probit models between the three treatment groups and the control group. This is different from the strategy followed by Castillo et al. (2010) for considering multiple treatments. They estimate a multinomial Logit for the probability of participating in the different programs using cross-sectional information. This paper does not follow this approach, because in the period under study, plants entered treatment in different years. Moreover, Probit allows a better balance of plants between treated and untreated using the procedure developed by Leuven and Sianesi (2003).

We use the predicted probability from these models for finding nonparticipant firms with similar probability of receiving treatment *j*. To select the appropriate control group for each treated plant, we use the five closer neighbors following Leuven and Sianesi (2003). The comparison between treated and control group for each treatment resulting from this procedure is shown in the appendix. In general, the matching is relatively successful in reducing the ex ante observable differences between treated and the control group for the common support.

Second, using the sample of treated and control in the common support, we estimate the impact of treatment for each pairwise comparison:

$$Log(Y_{ikt}) = \theta T_{jit} + X_{it}^{'}\beta + \alpha_i + \alpha_{kt} + \varepsilon_{ikt} \qquad (1)$$

where the Y_{ikt} is the interest outcome variable (employment, average wage, labor productivity, and total factor productivity[8]), T_{jit} is a dummy equal to 1 since the first year is treated until the end of the sample, X_{it} is a vector of control variables (specifically by age and age squared),[9] α_i is a plant-specific effect, and α_{kt} is a industry- and year-specific effect. This last set of dummy variables controls for common temporal shocks across 3-digit industries.

For the dependent variables, employment is defined as the number of workers, average wage as the total wage bill over the number of workers, labor productivity as real value-added per worker, and total factor productivity (TFP).

In equation (1), the average impact over the whole period of participation is captured by the parameter θ, and it is a useful indicator of the effect of the program. However, further relevant information can be obtained by studying the effect of the program over time. To do that, we modify equation (2) and define two dummy variables for treatment: one for the first three years since the plant is treated, and one for the following years (from the fourth year up to the end of the sample). This is not an arbitrary choice. Most of the programs last three years, and in FONDEF specifically, the first three years are mostly oriented to research in the technological centers associated with the project.

[8] Total factor productivity is computed as the residual from the estimation of 3-digit industry production functions using the methodology of Levinsohn and Petrin (2003).
[9] We control for these variables because due to learning effects related to age, impact indicators could show a different pattern according to firms of different seniority. These patterns—as the learning model suggests—could be non-linear. By controlling for these variables, we can be sure that we are comparing firms with similar patterns of learning over the intervention period.

6. Econometric Results

With regard to the propensity score, we estimate three different Probit models for the probability of participating in FONTEC, FONDEF, or both programs. In each case, the treatment variable is equal to 1 if that year the plant started a program, and zero otherwise. Treated plants are dropped from the sample after the first year of treatment. This is done to guarantee that they cannot be considered as untreated after that year, given that the idea is to identify factors affecting the probability of entering into a program.

We take as explanatory variables of the probability of participation several plant characteristics in the year before they were treated and the three years before growth rates in some variables. Specifically, we use employment, average wage, a dummy variable that takes value one if the firm is exporter, a dummy for foreign firms, a dummy for firms located in the metropolitan region (the capital of the country), a dummy for firms that have purchased foreign technical licenses, TFP, labor productivity, and industry dummies. All these variables are measured at t-1, where t is the year of start of the program. We also include the average growth in wages, employment, TFP, and labor productivity between t-3 and t-1 to control for differences in outcome trends across participating and nonparticipating firms.

Table 3 shows the results of the propensity score. In general, we find that larger plants (measured by the log of employment), more productive plants (measured by the log of value-added per worker), and exporters are more likely to participate in these programs. In the case of other level variables, we find that higher wages (a rough proxy for labor skills) increase only the probability of participating in FONTEC, and lower productivity increases the probability of participating in both FONTEC and FONDEF, but it does not affect the probability of using them simultaneously.

Another interesting result is that most of the growth variables are not statistically significant in relation to the probability of participating. Localization of firms in the capital city increases the probability of using FONTEC, but it reduces the probability of participating in FONDEF and both programs simultaneously.[10] Finally, the estimations show that purchases of foreign licenses (a proxy for efforts in technological innovation) only increases the probability of using both instruments jointly.

The basic results for FONTEC are shown in Table 4. Participation in FONTEC is positively associated with all performance variables under study, but it is only significant for employment and wages. According to these results, the effect on employment levels and average wages is 6.4 percent and 4.6 percent, respectively. The estimation of the impact of this program, using dummy variables for the first three years of treatment and from the fourth year up to the end, indicates some difference in the timing of the effects (Table 5). First, we find that the positive impact on employment is similar over time. Second, the positive effect on wages is concentrated in the first years of treatment. Third, in contrast to previous estimations, we find a positive impact of about 7 percent in TFP and labor productivity.

In the case of FONDEF, the results shown in Table 6 suggest more mixed outcomes. There is a negative effect of about 8 percent on employment, which could be associated with process innovation carried out by the treated firms. This finding is also consistent with the positive effect of FONDEF on labor productivity of about 10 percent. However, we find no significant impact on TFP and wages. Table 7, splitting the average impact between the first three-years and afterwards, reveals that the negative effect on employment is distributed almost homogenously over time, but the positive effect on labor productivity is not lasting.

[10] This result is consistent with the idea that FONDEF had a higher concentration in commodities processing industries that are located mostly in regions.

Table 8 presents the results of the impact of both programs used jointly by the firms. These results show some evidence of positive and large effects on both measures of productivity, on average about 24 percent. The effects on employment and wages are negative, but they are not statistically significant. The results in Table 9 show that the effects on TFP and labor productivity are larger after the first three years of participation in these programs.

In sum, our results reveal that participation in these programs is associated with improvements in the performance of the participants, with the exception of the negative effect of FONDEF on employment. We also find that there are relevant differences not only in terms of the variables under study but also in the timing of these effects. However, we caution that the low number of participants in these programs, especially in the case of firms using both of them, presents important methodological challenges for finding an adequate control group using standard techniques of propensity score matching. There are also limitations associated with the fact that we do not have information about intermediate results, such as measures innovation, that impede a deeper understanding of the effects of these program on these outcomes and how they might bring about changes in firm performance.

7. Conclusions

Using a large panel data of manufacturing plants during the period 1995–2008, we have evaluated the impact of two public programs, FONTEC and FONDEF, on several measures of firm performance. Given that we did not have access to information on innovation-related variables, we focused on four measures of performance: employment, wages, labor productivity, and TFP. We used two different specifications for understanding both the average positive effects and the dynamics of these effects over time.

Our results show that these programs are associated with increases in employment and productivity, but the impact is heterogeneous across programs and indicators of firm performance. FONTEC has had some positive effect on employment, wages, and both measures of productivity. However, the effect on productivity and wages is concentrated in the first three years of utilization of this program. In contrast, the impact of FONDEF was found to be negative on employment and positive on productivity (labor), without generating significant changes in wages or TFP. In addition, the evidence suggests a reinforcing positive effect on both measures of productivity when both programs were used.

One potential explanation of this last result may be associated with the market failures that these programs are aimed to ameliorate: (i) coordination problems and (ii) market failures related to asymmetric information and access to financing. The effects on productivity of using these instruments could be greater if public policies were to adopt a design that considers both subsidies to universities to solve the coordination failure and matching grants to firms to solve the liquidity constraints that could impede the implementation and scaling up of innovation projects. These findings could be an important contribution to policy discussions on the design of these instruments.

Table 1
Participating Firms by Program

	FONTEC	FONDEF	Both	FONTEC	FONDEF	Both	FONTEC	FONDEF	Both
	Number of Plants			Percentage			Accumulated		
1995	4	12	0	0.07	0.22	0.00	0.07	0.22	0.00
1996	15	13	1	0.25	0.22	0.02	0.32	0.43	0.02
1997	32	44	1	0.55	0.75	0.02	0.87	1.18	0.03
1998	47	56	2	0.83	0.98	0.04	1.70	2.17	0.07
1999	69	48	3	1.23	0.86	0.05	2.93	3.03	0.12
2000	66	54	3	1.20	0.98	0.05	4.12	4.01	0.18
2001	67	49	3	1.23	0.90	0.06	5.36	4.91	0.23
2002	80	59	7	1.40	1.04	0.12	6.76	5.94	0.35
2003	84	63	8	1.46	1.09	0.14	8.22	7.03	0.49
2004	60	60	5	1.04	1.04	0.09	9.25	8.07	0.58
2005	56	56	3	1.00	1.00	0.05	10.26	9.07	0.63
2006	51	63	6	0.97	1.20	0.11	11.22	10.27	0.75
Promedio	53	48	4	0.94	0.86	0.06	5.09	4.69	0.29

Source: Authors' elaboration based on information of ENIA, CONICYT and CORFO.

Table 2
Participating Firms by Program and Industry
Average 1995–2006

ISIC		FONTEC	FONDEF	Both
31	Food, beverages and tobacco	2.2	2.9	1.2
32	Textile, apparel and leather	0.7	0.1	0.0
33	Wood and wood products	0.6	2.6	0.5
34	Paper and paper products	1.3	1.3	0.4
35	Chemicals, petroleum, rubber and plastic	5.1	2.4	2.9
36	Non-metallic mineral products	1.4	2.3	0.0
37	Basic metal industries	4.3	10.1	0.5
38	Metal products, machinery, and equipment	3.8	0.6	0.3
39	Other manufacturing	0.8	0.8	0.0

Source: Authors' elaboration based on information of ENIA, CONICYT and CORFO.

Table 3
Estimation of the Propensity Score
Pooled Probit Model

	FONTEC	FONDEF	BOTH
Ln(employment)	0.0909**	0.321*	0.00633
	(.036)	(.051)	(.060)
Ln(average wage)	0.131***	0.115	0.0194
	(.075)	(.093)	(.128)
Ln(labor productivity)	0.154***	0.468*	0.282***
	(.084)	(.105)	(.147)
Ln(TFP)	-0.141***	-0.346*	0.0589
	(.081)	(.108)	(.153)
Employment growth	-0.00176	-0.0000882	-0.00311
	(.002)	(.003)	(.004)
Average wage growth	-0.00217**	0.00106	0.000347
	(.001)	(.001)	(.002)
Labor productivity growth	-0.00257	-0.00169	-0.00433
	(.004)	(.005)	(.007)
TFP growth	0.00316	0.000184	0.000459
	(.004)	(.005)	(.007)
Exporters dummy	0.252*	0.439*	0.0577
	(.071)	(.095)	(.131)
Foreign licenses dummy	-0.0335	-0.0501	0.299**
	(.108)	(.117)	(.143)
Capital region dummy	0.168**	-0.474*	-0.379*
	(.065)	(.095)	(.127)
Constant	-4.296*	-6.223*	-6.119*
	(.447)	(.580)	(.825)
Industry dummies	Yes	yes	yes
Observations	30,586	26,475	20,052

Standard errors in parentheses * $p<0.01$, ** $p<0.05$, *** $p<0.1$

Table 4

Estimates for the Impact Evaluation of FONTEC

Common Support Sample

	ln(employment)	ln(average wage)	ln(TFP)	ln(labor productivity)
Fontec	0.0622*	0.0450**	0.0569	0.0623
	(0.022)	(0.020)	(0.038)	(0.039)
Age	0.0372	0.0880*	0.3105*	0.3296*
	(0.032)	(0.029)	(0.055)	(0.056)
Age squared	-0.0006*	-0.0002***	-0.0008*	-0.0005*
	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Constant	3.6266*	7.3325*	4.4712*	4.9378*
	(0.367)	(0.335)	(0.633)	(0.646)
Observations	6,418	6,418	6,418	6,418

Standard errors in parentheses * p<0.01, ** p<0.05, *** p<0.1

Table 5

Estimates for the Timing of Impact Evaluation of FONTEC

Common Support Sample

	ln(employment)	ln(average wage)	ln(TFP)	ln(labor productivity)
First three years of treatment	0.0598*	0.0464**	0.0664***	0.0690***
	(.023)	(.021)	(.039)	(.040)
Fourth and later years of treatment	0.0691**	0.0411	0.0293	0.0431
	(.027)	(.025)	(.047)	(.048)
Age	0.0369	0.0881*	0.3115*	0.3303*
	(.032)	(.029)	(.055)	(.056)
Age squared	-0.0006*	-0.0002***	-0.0007*	-0.0005*
	(.0001)	(.0001)	(.0002)	(.0002)
Constant	3.6344*	7.3343*	4.4787*	4.9498*
	(.364)	(.333)	(.629)	(.642)
Observations	6,418	6,418	6,418	6,418

Standard errors in parentheses * p<0.01, ** p<0.05, *** p<0.1

Table 6

Estimates for the Impact Evaluation of FONDEF

Common Support Sample

	ln(employment)	ln(average wage)	ln(TFP)	ln(labor productivity)
Fondef	-0.0771**	-0.0087	0.0578	0.1006***
	(.031)	(.029)	(.055)	(.058)
Age	0.0605	0.1004*	0.0347	0.0145
	(.037)	(.034)	(.066)	(.069)
Age squared	-0.0007*	-0.0001	-0.0008*	-0.0007**
	(.0002)	(.0002)	(.0003)	(.0003)
Constant	4.2945*	7.2660*	8.8334*	9.2980*
	(.515)	(.475)	(.913)	(.963)
Observations	3,756	3,756	3,756	3,756

Standard errors in parentheses * p<0.01, ** p<0.05, *** p<0.1

Table 7

Estimates for the Timing of Impact Evaluation of FONDEF

Common Support Sample

	ln(employment)	ln(average wage)	ln(TFP)	ln(labor productivity)
First three years of treatment	-0.0794**	0.0046	0.0613	0.0998***
	-0.032	-0.029	-0.056	-0.06
Fourth and later years of treatment	-0.0694***	-0.0533	0.0458	0.1033
	(.039)	(.036)	(.069)	(.073)
Age	0.0602	0.1020*	0.0351	0.0144
	(.037)	(.034)	(.066)	(.069)
Age squared	-0.0007*	-0.0001	-0.0008*	-0.0007**
	(.0002)	(.0002)	(.0003)	(.0003)
Constant	4.2826*	7.2035*	8.8320*	9.3162*
	(.535)	(.493)	(.948)	(1.0)
Observations	3,756	3,756	3,756	3,756

Standard errors in parentheses * p<0.01, ** p<0.05, *** p<0.1

Table 8

Estimates for the Impact Evaluation of FONTEC and FONDEF

Common Support Sample

	ln(employment)	ln(average wage)	ln(TFP)	ln(labor productivity)
Fontec & Fondef	-0.0297	-0.0019	0.2415*	0.2384**
	(.048)	(.050)	(.093)	(.097)
Age	-0.0282	0.0054	-0.1123	-0.0449
	(.038)	(.040)	(.074)	(.078)
Age squared	0	-0.0002	0.0014*	0.0013*
	(.0002)	(.0003)	(.0005)	(.001)
Constant	4.5806*	8.6598*	10.3156*	10.0691*
	(.405)	(.426)	(.788)	(.823)
Observations	1,643	1,643	1,643	1,643

Standard errors in parentheses * p<0.01, ** p<0.05, *** p<0.1

Table 9

Estimates for the Timing of Impact Evaluation of and FONTEC and FONDEF

Common Support Sample

	ln(employment)	ln(average wage)	ln(TFP)	ln(labor productivity)
First three years of treatment	-0.0372	-0.0356	0.2021**	0.2060**
	(.050)	(.052)	(.097)	(.101)
Fourth and later years of treatment	-0.0104	0.0856	0.3439*	0.3225*
	(.058)	(.061)	(.113)	(.119)
Age	-0.0297	-0.0017	-0.1207	-0.0518
	(.038)	(.040)	(.074)	(.078)
Age squared	0	-0.0001	0.0015*	0.0014*
	(.0002)	(.0003)	(.0005)	(.001)
Constant	4.6028*	8.7325*	10.3777*	10.0970*
	(.411)	(.432)	(.801)	(.836)
Observations	1,643	1,643	1,643	1,643

Standard errors in parentheses * p<0.01, ** p<0.05, *** p<0.1

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APPENDIX

Differences between Treated and Control Group

FONTEC

Variable	Sample	Mean		Percent bias	Percent reduction bias	t-test	
		Treated	Control			t	p>t
ln(employment)	Unmatched	3.934	3.360	54.8		8.080	0.000
	Matched	3.937	3.905	3.1	94.3	0.300	0.764
ln(average wage)	Unmatched	8.315	7.855	83.8		10.980	0.000
	Matched	8.330	8.264	12	85.6	1.270	0.206
ln(labor productivity)	Unmatched	8.808	8.169	73.9		9.840	0.000
	Matched	8.818	8.722	11	85.1	1.110	0.266
ln(TFP)	Unmatched	8.172	7.345	56.3		8.380	0.000
	Matched	8.172	7.958	14.5	74.2	1.410	0.161
Employment growth	Unmatched	-1.175	-2.950	9.3		1.170	0.242
	Matched	-1.175	-0.416	-4	57.3	-0.450	0.654
Average wage growth	Unmatched	7.424	8.052	-4.6		-0.510	0.608
	Matched	7.424	6.583	6.2	-33.7	0.720	0.469
Labor productivity growth	Unmatched	4.456	-0.556	14.7		1.710	0.087
	Matched	4.456	1.387	9	38.8	0.960	0.337
TFP growth	Unmatched	3.043	-1.889	14.6		1.710	0.087
	Matched	3.043	0.778	6.7	54.1	0.700	0.481
Exporters dummy	Unmatched	0.399	0.162	62		9.850	0.000
	Matched	0.403	0.391	3.2	94.8	0.280	0.777
Foreign licences dummy	Unmatched	0.084	0.042	23.8		3.750	0.000
	Matched	0.086	0.080	3.5	85.3	0.310	0.757
Capital region dummy	Unmatched	0.678	0.558	25		3.420	0.001
	Matched	0.673	0.727	-11	56	-1.150	0.253

FONDEF

Variable	Sample	Mean Treated	Mean Control	Percent bias	Percent reduction bias	t	p>t
Ln(employment)	Unmatched	4.944	3.361	144.3		19.400	0.000
	Matched	4.963	5.029	-6	95.8	-0.490	0.621
Ln(average wage)	Unmatched	8.592	7.856	119.2		15.240	0.000
	Matched	8.605	8.472	21.5	81.9	1.810	0.071
Ln(labor productivity)	Unmatched	9.515	8.169	122.8		17.870	0.000
	Matched	9.552	9.412	12.8	89.6	1.060	0.291
Ln(TFP)	Unmatched	9.357	7.346	94.4		17.370	0.000
	Matched	9.418	9.067	16.5	82.5	1.270	0.205
Employment growth	Unmatched	0.239	-2.944	15.8		1.830	0.067
	Matched	0.010	1.985	-9.8	37.9	-0.890	0.377
Average wage growth	Unmatched	7.285	8.048	-5		-0.540	0.589
	Matched	7.386	6.978	2.7	46.6	0.270	0.789
Labor productivity growth	Unmatched	-1.399	-0.571	-2.2		-0.250	0.806
	Matched	-2.120	0.055	-5.7	-162.5	-0.670	0.505
TFP growth	Unmatched	-3.063	-1.901	-3.2		-0.350	0.725
	Matched	-3.775	-0.190	-9.9	-208.5	-1.190	0.233
Exporters dummy	Unmatched	0.719	0.162	150.5		20.190	0.000
	Matched	0.736	0.725	2.8	98.2	0.220	0.826
Foreign licences dummy	Unmatched	0.142	0.042	49.1		7.840	0.000
	Matched	0.145	0.168	-11.2	77.2	-0.730	0.464
Capital region dummy	Unmatched	0.217	0.557	-74.5		-8.400	0.000
	Matched	0.228	0.250	-4.8	93.5	-0.440	0.661

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Variable	Mean Sample	Treated	Control	Percent bias	Percent reduction bias	t	p>t
Ln(employment)	Unmatched	3.667	3.361	23.5		2.540	0.011
	Matched	3.662	4.441	-59.8	-154.5	-3.370	0.001
Ln(average wage)	Unmatched	8.651	7.855	136.3		11.180	0.000
	Matched	8.658	8.815	-26.8	80.3	-1.570	0.118
Ln(labor productivity)	Unmatched	10.348	8.169	196.6		19.680	0.000
	Matched	10.390	10.156	21.1	89.3	1.140	0.257
Ln(TFP)	Unmatched	9.747	7.345	166.5		14.410	0.000
	Matched	9.775	9.493	19.6	88.3	0.990	0.325
Employment growth	Unmatched	-0.836	-2.947	12.8		0.830	0.409
	Matched	-1.202	-0.268	-5.6	55.8	-0.440	0.664
Average wage growth	Unmatched	6.475	8.052	-10.7		-0.760	0.448
	Matched	6.659	7.627	-6.5	38.6	-0.480	0.635
Labor productivity growth	Unmatched	2.610	-0.557	10		0.640	0.523
	Matched	3.019	-5.875	28.1	-180.9	2.280	0.024
TFP growth	Unmatched	1.350	-1.888	10.6		0.670	0.506
	Matched	1.539	-8.519	33.1	-210.7	2.760	0.007
Exporters dummy	Unmatched	0.439	0.162	75.8		6.820	0.000
	Matched	0.430	0.641	-57.7	23.8	-3.000	0.003
Foreign licences dummy	Unmatched	0.209	0.042	73.6		8.880	0.000
	Matched	0.216	0.219	-1.3	98.2	-0.060	0.954
Capital region dummy	Unmatched	0.261	0.558	-63.1		-4.950	0.000
	Matched	0.254	0.275	-4.4	93	-0.270	0.786