

# Technology Adoption and Specialization Dynamic of Uruguayan Breeders: Evidence from an Impact Evaluation<sup>1</sup>

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## Abstract

In this paper, we analyzed the effectiveness of the Livestock Pilot Project (LPP) in fostering the efficiency of the Uruguayan livestock producers. We found that the LPP had an overall positive impact on the adoption of managerial practices, but it had not significant impact on both productivity and specialization. However, we found positive effects of the PPL also on productivity when we restricted the analysis to the producers specialized in the breeding stage. In particular, we found that the Reproductive Efficiency Index (REI) of the beneficiary breeders is 6.7 percentage points higher than the REI of the non-beneficiaries. In economic terms, this result means an average income increase of US\$5,960 for the beneficiaries. These results notwithstanding, we found that the project is only partially successful in fostering the breeders' rate of specialization, probably due to a still too high risk aversion towards complete specialization. Finally, we found that the LPP had no differentiated effects depending on the size of subsidy received by the producers. Therefore we could not identify any threshold in the subsidy intensity that significantly affects the project effectiveness. We estimated these effects through a quasi-experimental approach that combines difference-in-difference and propensity score matching techniques, in order to control for potential selection bias in the absence of a randomized experiment. We used a unique panel dataset of 520 beneficiary and 470 non-beneficiary producers, dataset that we constructed by merging information from the Uruguayan livestock Survey of 2001 and 2003 with information collected by the PLP's Coordinating Unit.

**JEL Codes:** Q12, Q16, H43

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## **Introduction**

During the 90s the Uruguayan livestock industry experienced significant improvements in its commercial performances, mainly thanks to the liberalization of meat export, the de-regulation of the meat processing and the Uruguay's status of country free from foot-and-mouth disease. These results notwithstanding, at the end of the 90s the Uruguayan livestock sector still showed a relevant productivity gap when compared with international competitors such as Argentina and New Zealand. For this reason, at the end of the year 2000, the Uruguayan Government, with the technical and financial support of the Inter-American Development Bank, introduced the Pilot Project to enhance the Competitiveness of the Livestock sector, henceforth referred to it as Livestock Pilot Project (LPP). This project aimed at enhancing productivity and specialization throughout the livestock production chain, by promoting technological, organizational and commercial innovations, with particular attention to the inclusion of small and medium breeders. For this purpose, the project provides matching-grants to finance innovation project designed and developed by Uruguayan producers.

The paper reports the results of the impact evaluation of the LPP on management, productivity and specialization indicators. Our results show that the project positively affected the rate of adoption of management practices, such as keeping record of physical and economic events. Our results also show that the project positively affected the productivity of the livestock producers specialized in the breeding stage. In particular, we found that the Reproductive Efficiency Index (REI) of the beneficiary breeders is 6.7 percentage points higher than the REI of the non-beneficiaries. In economic terms, this result means an average income increase of US\$5,960 for the beneficiaries. These results notwithstanding, we found that the project is only partially successful in fostering the breeders' rate of specialization, probably due to a still too high risk aversion towards complete specialization. Finally, we estimated the heterogeneity of the impacts on different cluster of beneficiaries grouped on the basis of the amount of financing received. This particular extension of the analysis aimed at testing the hypothesis of potential "dosage effects" of subsidy. We did not find evidence of any significant dosage effect of the subsidy on productivity; therefore we could not identify any threshold in the subsidy intensity that significantly affects the project effectiveness.

We used 2001 and 2003 data from Livestock Survey (DIEA-MGAP) and Project Coordination Unit (UCP) to set up a unique panel dataset. After processing these databases, we obtained 990 observations, 520 for beneficiaries and 470 for non beneficiaries. Descriptive statistics shows high mobility in productive specialization of producers and significant producer and exploitation differences between beneficiaries and control group.

Drawing on this unique dataset, we estimated the project impacts adopting a difference-in-difference with propensity score matching estimation strategy. These estimation techniques allowed us to minimize the effect of selection biases by identifying balanced treated and control samples of producers and by controlling for time-invariant unobservable covariates. In particular, the first stage matching procedure allowed us to detect significant differences between the treated and the non-treated group. We were

able to define a participation model that is robust in different specification and shows significant differences in terms of producers' personal characteristics, and the farm managerial and technological characteristics. Testing after the matching, we found that the selected and treated groups were balanced in all the relevant covariates.

Following this introduction, this paper will be organized as follows: section 1 briefly describes the recent evolution livestock industry in Uruguay. Section 2 describes the structure of the LPP. Section 3 discusses the economic rationale for the LPP. Section 4 presents the methodology and describes the data used. Section 5 discusses the main findings and section 6 concludes.

## **1. The Recent Evolution of the Livestock Sector in Uruguay**

From 2000 to 2005 the agricultural sector accounted for 9% of Uruguay's GDP. The production generated by the industries linked to this sector represented 5.4% during this period, thus, giving the agricultural sector a contribution of 14.4% of GDP. During this period, the cattle sector accounted for 33% of agricultural production and for nearly 5% of GDP. In the external sector, agricultural exports represent almost 75% of all Uruguayan exports. The volume of exports for bovine meat increased from 177 to 292 metric tons during 2000-2005, while the value of bovine exports increased from US\$369 to US\$765 million during the same period.<sup>3</sup>

The base of the Uruguayan livestock sector consists of 14 thousand farms, which include 12 million head of cattle and 9.8 million head of sheep based on the Agricultural Census of 2000. The livestock sector utilizes 61% of the 11.7 million hectares of the agricultural surface and it accounts for 83,000 permanent workers. Eighty-eight percent of the farms are small-scale (with less than 500 head of cattle) and they work on 53% of the exploited surface.

During the 1990's, the livestock sector experienced significant improvements in the commercialization of products, opening of new markets, and in 1996, it attained the foot-mouth-disease-free status "without vaccination". Nevertheless, scholars and policy makers agreed that more improvements needed to strengthen the competitive position of the Uruguayan livestock sector.

Similarly, there was a general consensus that the productivity indicators were lagging and that the speed of adoption of management practices was slow in comparison with other countries with similar comparative advantages. In fact, the livestock survey shows that non beneficiaries reached a 40% of weaning for beneficiaries and 50% for non beneficiaries, and only the 20% of breeders kept register of physical and economic registries. The survey also illustrated the heterogeneity of producers' characteristics, procedures and techniques in stable management. This heterogeneity was apparently associated with the disparities in the productivity indicators. Explanations for this phenomenon were found in the current modes of the articulation of the production chain which did not facilitate taking advantage of specialization, and in the low productive management levels of small-scale producers who have not had the opportunity to

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<sup>3</sup> Source: DIEA-MGAP, INE and Central Bank of Uruguay.

participate in the learning processes and technological changes as in other countries (IDB 2001).

In this context and after a series of government measures, the initiative to develop a pilot project for the livestock sector for 2001-2003 emerged, one which aims to introduce and validate novel institutional strategies to increase the competitiveness of the Uruguayan livestock sector, through the adoption of innovations by private agents throughout the entire production chain, with an emphasis in small-, and medium-scale breeders, in order to increase the productivity of the sector.

The implementation of the pilot project, during 2001 and 2003, coincided with a period of marked macroeconomic and sectoral instability. Indeed, the level of indebtedness of the livestock sector reached 115% of the agricultural GDP in 2000, the Uruguayan GDP fell 3.8% in 2001 and 11.8% in 2002. The resurgence of the foot-and-mouth disease in April of 2001 caused a decrease of 26% in the slaughtering rate going from 1.9 million to 1.4 million heads annually, the prices for fattened steer for exports decreased from 0.78 US\$/Kg. in 2000 to 0.51 US\$/Kg. in 2001 and 0.53 US\$/Kg. in 2002. Exports went from US\$369 million in 2000 to US\$217 million in 2001. Additionally, the impact of foot-and-mouth disease was accentuated by the appreciation of the real exchange rate, which reached 6% between April of 2001 and June of 2002. It is estimated that the resurgence of foot-and-mouth disease accounted for 2% in the reduction of GDP in 2001 and 1.5% in 2002. In 2003 the macroeconomic environment improved as there was an increase in the real exchange rate of 56% from June 2002 to December of 2003, and as the country regained its foot-and-mouth-disease-free status 'with vaccination' (IDB 2001). The international prices for meat returned to 2000 levels, as well as the production and slaughtering rate of cattle.

## **2. Pilot Project for the Livestock Sector 2001-2003**

The main objective of the pilot project consisted in introducing and validating novel institutional strategies to increase the competitiveness of the Uruguayan livestock sector through the adoption of innovations by private agents all along the production chain, with a particular emphasis on small- and medium-scale farms. To reach this objective, the project was formulated with a base of three components geared to promote innovations at the breeding stage (Component I), in linkage of the production chain (Component II), and in commercialization of new products and access to new markets (Component III).

This paper focuses on the project's component I. The reason for this choice is due to components II and III lacking the necessary information to conduct an impact evaluation of a traditional nature.<sup>4</sup>

According to the LPP original design the eligibility criteria to participate in component I were the following:

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<sup>4</sup> Beneficiaries of components II and III do not have information related to their individual characteristics, property or management indicators that would allow simulating a randomization of the intervention *a la* Rosenbaum-Rubin (1983).

- The size of the beneficiaries' farm should be within the range of 300 and 1,250 CONEAT-100<sup>5</sup> hectares, with a maximum of 10% of producers exceeding these limits.
- The proposal should be selected on the basis of the Net Present Value (NPV) per hectare.
- The producers should be supervised by a private facilitator.
- The facilitators should supervise between 10 and 100 producers.

The producers that applied for component I of the LPP had the opportunity of getting a subsidy of US\$7 per hectare, with a ceiling of US\$7,000<sup>6</sup>. These resources allowed for the financing of 25% of eligible expenses reported in the business plan submitted to the Project Coordinating Unit (PCU) through the facilitators. The facilitators supervise the preparation of business plans and are the counter-part to the executing unit, which are audited afterwards by an independent entity. Eligible expenses of the business plan include expenses for technical assistance, pasture improvement, services and materials. Payments were made in three installments: 20% at the approval of the business plan, and the remaining 80% in two installments proportional to the percentage of fulfillment of the objectives defined in the business plan at the end of the first and second year of execution, respectively. In a complimentary fashion, a subsidy of US\$250 was given to cover the costs for the preparation of the business plan.

The design of the LPP aimed at inducing the private to take leadership of the innovation process through two fundamental mechanisms: first, by leaving the selection of business plans in the hands of private facilitators; second, by leaving the definition of the innovative project in the hands of the producers.

A more detailed review of the LPP functioning reveals how these mechanisms, if not adequately monitored, may generate some perverse incentives. In fact, since the facilitators are responsible for identify the potential beneficiaries<sup>7</sup> and given that their earnings are directly related to the results attained by the beneficiaries, they are plausibly induced to look for potential beneficiaries that have the initiative, disposition and capacity to implement innovations. Therefore, the facilitators could be induced to pre-select those business plans that include innovations already validated to minimize the risks associated with the fulfillment of objectives. Generally speaking, we can expect that the facilitator would maximize its own benefits by selecting the business plans of producers that have a high probability of accomplishing the planned goals and that require a low level of supervision and mentoring, i.e. those producers that have the

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<sup>5</sup> CONEAT is an indicator of productive capacity of the soil established by the National Commission of Agro-economic Land Studies. CONEAT-100 is the average quality level of the soils in the country.

<sup>6</sup> To make a sense of the magnitude of the subsidy we could consider that 1 ton. of exported meet has a value of US\$1450.

<sup>7</sup> The probability that a small-scale producer approaches a facilitator is a bit smaller. In fact, according to the livestock survey of 2001 only 45.6% of the livestock producers knew of the existence of the program. Of these, 35.4% of them learned about this through the radio, 22.6% through the press, 19% through an agricultural technician, 11.6% through an agricultural guild, and 5.8% through another producer.

disposition and capabilities to innovate by themselves and those innovation project that have already been largely validated.

It is important to note that the facilitators are the ones in charge of verifying the fulfillment of goals on behalf of the producers. However, facilitators' earnings are directly linked to the percentage of attained goals, and then they could have an incentive to lie about the goals of beneficiaries. In order to decrease this potential conflict of interest between the project's executing agency and facilitators, a system of independent auditing was used with the aim of verifying the veracity of the information given by facilitators. Considering a sample of 12% of business plans, a tendency of under-reporting the initial value of result indicators of each business plan was reported, but not in an excessive fashion (Quiroz, 2003).

On a different note, the fact that a facilitator manages between 10 and 100 business plans can foster the creation of clusters or networks of producers and technicians, which allows for the potential diffusion of best management practices as well as the generation of opportunities that amplify the possibilities of increasing the associations between small-scale producers, a process that in the economic literature is known as *knowledge spillover*.<sup>8</sup>

The temporary structure of the disbursements of subsidies makes it highly illiquid because these were paid after demonstrating the attainment of objectives. Also, disbursements were pro-cyclical, in the sense that grew proportionally to accomplishment of the targets, in this sense, in the case of macroeconomic or sectorial conditions, the subsidy also moved in the same way. Additionally, for the producer, the subsidy works as a long position in a call option whose underlying asset is the percentage of the attained goals. Consequently, the subsidy is perceived as a prize for the adoption of innovations with positive effects in the business. The maximum amount of the subsidy of US\$7/ha represents between 1% and 8% of annual earnings of livestock exploitations per hectare, according to the figures of income from the livestock survey of 2001. In actuality, 93% of business plans were executed satisfactorily, fulfilling at least 70% of intended goals. The average subsidy was between US\$3,500 and US\$4,500 for 75% of project beneficiaries.<sup>9</sup>

The project was planned for two years, during which producers had to design and send their innovative business plans for review; results had to be verifiable at the end of the first and second year so that the subsidy could be collected. This feature creates a framework where the development of business plans that incorporate biological processes or of soil improvement and that require longer periods to observe the results, have a lesser probability of obtaining the benefits of the subsidy and therefore also have a lesser probability of participating in this process.

In the practice, the implementation of the project began with an open call to private agents to participate as facilitators. During this first phase 25 facilitators were selected from a total of 33 candidates. The selected facilitators identified and presented a total of 1,027 business plans to the PCU, of which 850 were selected. Once the business plans

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<sup>8</sup> Source: Romer (1986), Romer and Lucas (1988), Porter (1990), Shaver and Flyer (2000).

<sup>9</sup> Source: "Project Completion Report (PCR)" corresponding to the loan OC-UR/1299 presented to the Inter-American Development Bank, April 2004.

were approved and the 20% of subsidies were disbursed, the facilitators were responsible for verifying the attainment of the objectives required for the further disbursements.

The project had a total coverage of 795 thousand hectares, 521 thousand head of cattle and 751 thousand head of sheep dispersed in a significant share of the country. According to the Project Coordinating Unit, the costs of component I reached US\$3.99 million.

In relation to the administration, it is important to note that the PCU relied on an information system especially designed to capture and monitor beneficiaries' information in real time. This allowed setting up a baseline, to carry out an informed administrative process, and to monitor the agreed upon indicators that allowed for a permanent self-evaluation.<sup>10</sup>

### **3. Rationale for the Model of Intervention [section to be revised]**

The economic literature has developed arguments in favor and against government intervention aimed to increase the productivity and competitiveness of a specific sector of the economy through the promotion of innovations. Indeed, the benefits associated with innovation processes present characteristics of a quasi public good, thus, as far as the innovator goes, in general, s/he does not appropriate the benefits generated by his/her innovation. In this manner, once a technology has been validated and applied there will be producers that will benefit by imitation without incurring the costs associated with the innovative process. In this context, the market on its own leads to levels of investment in research and development that are inferior to socially optimal ones, as it promotes free-rider tendencies, thus, some form of government participation in the promotion of innovations is suggested (Atkinson y Stiglitz, 1980). The protection of property rights and patents are put forth as a solution to this problem (Lanjouw et al, 1998). An argument against the former is proposed by Merton (1988) who highlights the advantages of being the first. Likewise, it is argued that the profitability of the market guides the innovative processes in a way that is efficient (Koppel, 1995). Another argument is based on the belief that producers have incentives to mobilize their resources in order to persuade public institutions to diminish the costs of innovation. These resources do not generate wealth and therefore constitute a loss for society (Murphy et al 1991, Lenway 1996).

[TO BE COMPLETED]

Notwithstanding theoretic arguments and empirical evidence in favor of state intervention in the agricultural sector, there is a long interventionist tradition that, in general, is not based on such arguments. In fact, despite the world-wide tendency toward the liberalization of the markets, the agricultural sector, currently, accounts for a high

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<sup>10</sup> For a more detailed discussion of these aspects, please review "Project Completion Report (PCR)" corresponding to the loan OC-UR/1299 presented to the Inter-American Development Bank, April 2004.

percentage of subsidies provided by governments.<sup>11</sup> Eighty-one percent of global subsidies are destined to the agricultural/fishery, transport and energy sectors. These subsidies affect 66% of world trade. If the manufacturing sector is added, then, 87% of subsidies affect 97% of world trade (Pearce, 2002). The magnitude of these subsidies generates distortions in the productive structure and trade patterns. Among the more common types of subsidies are the market-price subsidies (60%), payments based on the number of head of livestock or land extension (12%), payments based on inputs (9%) and based on production (8%).<sup>12</sup>

With regards to the Uruguayan livestock sector, there are arguments in favor of government interventions aimed at exploiting the potential positive externalities associated with the acceleration of the innovative processes in small-, and medium-scale producers.

Referring to the theoretical and empirical evidence that support a positive relationship between innovation and productivity, we reviewed the structure of incentives put in place by the LPP with the aim of promoting innovation amongst small-, and medium-scale producers.<sup>13</sup> For this purpose, we needed to identify the causes for the lagging of the innovative processes. Although, we could not find any study that addresses the determinants of technology adoption in the case of Uruguay, we could rely on theoretical and empirical studies that analyze the determinants of innovation and technology adoption by small-scale producers [add references]. Among these factors, the literature identifies the characteristics of the individual (idiosyncratic factors, human capital, personality, motivation, cognitive abilities, job characteristics), the characteristics of the work group (members' characteristics, work environment, chain of command, leadership style), organizational characteristics (culture, strategy, size, resources) and the characteristics of the business environment (intellectual property rights, market structure, openness of the economy, government participation in the sector, financial system).<sup>14</sup>

At the time of the design of the LPP, there was no convincing evidence that would allow determining the incidence of each of these possible causes for the lagging of the innovative processes. Therefore, to facilitate the analysis of the LPP logic of intervention, we assumed five potential profiles of non-innovative producers. Although these profiles do not necessarily capture the heterogeneity of the conditions of livestock producers, they allow us to synthetically illustrate the economic incentives of potential participants in the LPP.

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<sup>11</sup> According to the OECD, a subsidy is a policy geared toward individuals and enterprises that increases their income or that reduces their costs, and in this manner it affects production, consumption, commerce, income and the environment. (Portugal, 2002). The OECD uses the PSE (Producer Support Estimate) to determine the monetary value of the gross transfers of consumers and taxpayers to agricultural producers. These transfers are classified based on the mechanism used for the transfer: area planted or number of animals, historical rights, use of inputs, input restrictions and production income. One discussion on the PSE can be found in Legg (2003), Oskam and Meester (2006) and Tangermann (2005 and 2006).

<sup>12</sup> Dionne, S., K. Mayrand, M. Paquin and I. Pageot-Lebel (2003). "The Economic and Environmental Impacts of Agricultural Subsidies: An Assessment of the 2002 US Farm Bill & Doha Round". Unisfera International Centre Draft Paper.

<sup>13</sup> For a review of the international experience it is suggested to see Ahmad et al (2001), Gali et al. (2003), Pianta (2005), Aghion et al. (2005), Goedhuys (2007).

<sup>14</sup> Morck and Yeung (2001), Anderson et. al (2004), De Jong (2006).

- i. Profile 1: The producer has no interest in innovating, primarily due to factors of culture, idiosyncrasy and human capital.
- ii. Profile 2: The producer does not know the practices that would allow him/her to increase the productivity of his/her farms, due to low levels of human capital and/or information.
- iii. Profile 3: The producer knows some practices that would allow him/her to improve his/her productivity, but in the event of a costly innovation, his/her perception of the risk associated with the undertaking of a process of innovation, increases in a significant way the probability of bankrupting the business.
- iv. Profile 4: The producer has ideas that would allow him/her to improve productivity but has no access to the resources to implement them.
- v. Profile 5: The producer has innovative ideas, the disposition and the resources to implement them.

It is not very likely that the producers depicted in profiles 1 and 2 would participate in the project. In the case of profile 1 it would be more costly for the facilitator to convince him/her to participate and to implement the innovations in his/her business. If to this we add, for both profiles, a low level of human capital or management capabilities, the probabilities of accomplishing the intended goals are diminished, and thus the expected net benefits of the business plan are reduced, along with the possibility that the producers with these profiles be actually selected and motivated by facilitators to participate in the project.

In the case of the producer with profile 3, the project turns out to be attractive for a low-cost innovation. However, if the innovation is costly and sufficiently risky, the pro-cyclical nature of the subsidy makes this instrument unattractive, and thus it does not have a significant effect in the reduction of the probability of bankruptcy under an unfavorable situation.

Considering the producer with profile 4, the previous argument applies from the perspective that the project's subsidy becomes attractive for innovations with low risk and low costs. Nonetheless, the illiquidity of the subsidy as well as the amount of the initial subsidy, suggest that the livestock project does not contribute to the development of high-cost innovations, and therefore the solution to this problem has to come from the access to a capital market that would allow him/her access to credit for the financing of the innovation.

Finally, the producer with profile 5 has the greater possibility of participating in the livestock project. Indeed, his/her job consists in formalizing his/her innovative initiatives in the context of a business plan. In this scenario the producer receives the good news that his/her innovation plan will qualify for a subsidy of 25% of the costs, and thus, reduce the costs of the innovation. In this context, the project's incentives lead to a substitution of private resources at the expense of non-reimbursable public resources.<sup>15</sup> At the end of the project it is reported that for each dollar of subsidy the private sector

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<sup>15</sup> In the literature of subsidies, innovation and technology, this phenomenon is known as "Crowding Out."

contributed US\$2.6.<sup>16</sup> This amount is considered successful when compared to the initial goal that aimed for one private dollar for each dollar of subsidy, however, the available information does not allow to determine what part of these resources that were raised are due to the development of the project.

#### 4. Methodology and Data

An impact evaluation or ex-post evaluation, in quantitative terms, consists in determining the changes in the result indicators that are attributable to the project while “eliminating” the effect of other factors that may simultaneously influence each indicator. This fact becomes relevant as much as for the volatility of the macroeconomic environment and of the livestock sector in which the project was developed, and as for the differences between the characteristics of the beneficiaries and non-beneficiaries to the project.

In the actual practice, it seeks to determine the variation in the result indicator of each of the project beneficiaries given the fact that they were beneficiaries to the project minus the variation of such said result indicator for these same beneficiaries in the event that they had not received the benefits of the project. This result is impossible to observe, thus, other individuals in their natural state are observed, that is, if they were beneficiaries or not. In order to overcome this difficulty, the variation of the result indicator of beneficiaries is compared with the variation of the result indicator for those producers with similar characteristics as the beneficiaries but who did not receive the benefits of the project.

This procedure is called “matching” and the ability to arrive at the quantification of the evolution in the result indicators attributable to the project depends on the ability of creating an adequate group for comparison.

Considering the following notation:

Y<sub>i</sub>: Change in the value of the result indicator between 2003 and 2001 for farm “i”

T: Dichotomous variable that takes the value of 1 for those farms that were beneficiaries to the livestock project and 0 otherwise.

X<sub>i</sub>: Is a vector of characteristics associated with the farm i.

E[ ]: Expected Value

The returned results reported in this evaluation report can be denoted by the following expression:

$$DDS = E[Y(T=1)/X, T=1] - E[Y(T=0)/X, T=0], \quad (1)$$

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<sup>16</sup> Source: “Project Completion Report (PCR)” corresponding to the loan OC-UR/1299 presented to the Inter-American Development Bank, April 2004.

which is known in the literature as Biased Difference-in-Difference (BDD) estimator. However, we are interested in determining the value of the following indicator.

**Average Treatment Effect on the Treated:** This indicator allows to determine the variation of the result indicator for beneficiary farms attributable exclusively to project participation.

$$(ATT= E[Y(T=1)-Y(T=0)/X, T=1]) \quad (2)$$

It is possible to mathematically show that if the groups of beneficiaries and non-beneficiaries are selected randomly, the ATT and BDD indicators are identical. However, project participation is not randomly assigned, and it is therefore necessary to use a method that allows for the construction of a control group that is comparable to the group of beneficiaries.

The method that is commonly used to calculate ATT indicators is of a non-parametric type and it consists in determining a model with the variables that explain the participation in the project, using a discrete model based on a database of beneficiaries and non-beneficiaries. From this model, the conditional probability to participate in the project (propensity score) is obtained for each farm. In this approach, one seeks to compare the variation in the result indicator of each beneficiary who has a particular probability to participate in the project, with one or more non-beneficiaries that had the same probability to participate in the project in the baseline. Rosenbaum and Rubin (1983) have demonstrated that the propensity score eliminates the biases associated with the differences in observable characteristics of the individuals that belong to the treatment group and the control group, at the time of project implementation. A methodological revision is found in Blundell and Costa Dias (2002).<sup>17</sup> Subsequently, the difference in the changes of the result indicators is calculated between beneficiaries and a group of controls that have similar propensity scores. From this number an average is calculated for each of the beneficiaries and thereby the ATT indicator is obtained. In the literature, different methods are suggested to construct the control group, Becker & Ichino (2002)<sup>18</sup>. The quality of each of the methods lies in their ability to decrease the differences between the group of beneficiaries and the control group for the sample with which the impacts are calculated, Lee et al. (2006). In order to verify this capability, t-statistics are performed on the characteristics of beneficiaries and the control group.

The work was conducted with a panel data of 990 observations for the years 2001 and 2003, of which 520 were for beneficiaries and 470 non-beneficiaries. The dataset was

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<sup>17</sup> Blundell, R. and M. Costa Dias (2002). "Alternative Approaches to Evaluations in Empirical Microeconomics". *Cemmap Working Papers*, CWP10/02. For elaborations on the methodology see Heckman et al. (1998), Dehejia and Wahba (1999), Abadie and Imbens (2005).

<sup>18</sup> A description of the methods is found in: "Estimation of average treatment effects based on propensity scores", *Stata Journal* 2(4), 358-377.

collected in order to obtain a representative sample at national level, according to agricultural census raised in 2000. Notwithstanding, the beneficiaries weren't randomly selected and they are not a representative sample of the population, a non experimental evaluation design was required to assess the impacts. The dataset includes the characteristics of the producer, administrative management indicators, technical assistance indicators, and indicators for implementation and technology. It is made sure that the farms in consideration have data on both time periods and that the extensions of the farm are the same and with the same CONEAT index. The data for the group of beneficiaries was obtained thanks to the PCU's information system. The data for non-beneficiaries was obtained from the livestock survey that was implemented during 2001 and 2003 by the Dirección de Estadísticas Agropecuarias (DIEA).

## 5. Empirical Results

### *Participation Model*

As it was argued in section 3, the characteristics that differentiate beneficiaries from non-beneficiaries could be reflected in the characteristics of the beneficiaries along with the facilitators' preferences. This aspect is of no small significance, since it introduces potential biases at the time of determining what part of the improvement in the result indicators is attributable to the execution of the project and not to the selection of the farms. This fact justifies the use of a method that allows for the construction of an appropriate control group.

When the similarities of the characteristics between the group of beneficiaries and the control group are analyzed, significant differences are found in the spheres of some of the characteristics, such as geographical, territorial, breeders' training, as well as in implementation and management indicators. Indeed, looking at tables 1 and 2, the sample of beneficiaries is characterized by having an average of 919 has in contrast to the 2,622 has of the control group, 13% of producer beneficiaries are located in Montevideo in contrast to 3% of the control group. In terms of the quality of the soil, the CONEAT index does not reflect any significant differences between beneficiaries and the control group, presenting an average of 92 for the control group and 91 for the group of beneficiaries. When comparing the characteristics of the producers it was found that the average age of beneficiaries is 47 years old versus 54 years for breeders in the control group. Four-point-six percent (4.6%) of beneficiaries show to have higher education levels (technical and university), while only 1.7% of non-beneficiaries show to have some form of higher education. Finally, 43% of breeder beneficiaries to the livestock project have some form of work outside the farm, in contrast to 27% in the control group. In the area of technical assistance it is shown that 73% of beneficiaries receive technical assistance from a private agronomist and 91% receive technical assistance from a private veterinary, compared with 91% and 95% for the control group, respectively. Additionally, 23% of beneficiaries participated in at least one of MGAP's programs in the past, compared to 6% of the control group. Finally, in relation to the indicators of implementation and technology it can be observed that 26% of project beneficiaries implemented bulls' check-ups and 65% implemented some form of pregnancy diagnosis, compared with 62% and 53% for the control group, respectively. Seventy percent (70%)

of beneficiaries had registries of physical events and 78% of registries for economic activities, compared with 69% and 74% for the control group.

**Table 1**  
**Descriptive Statistics: Beneficiaries**

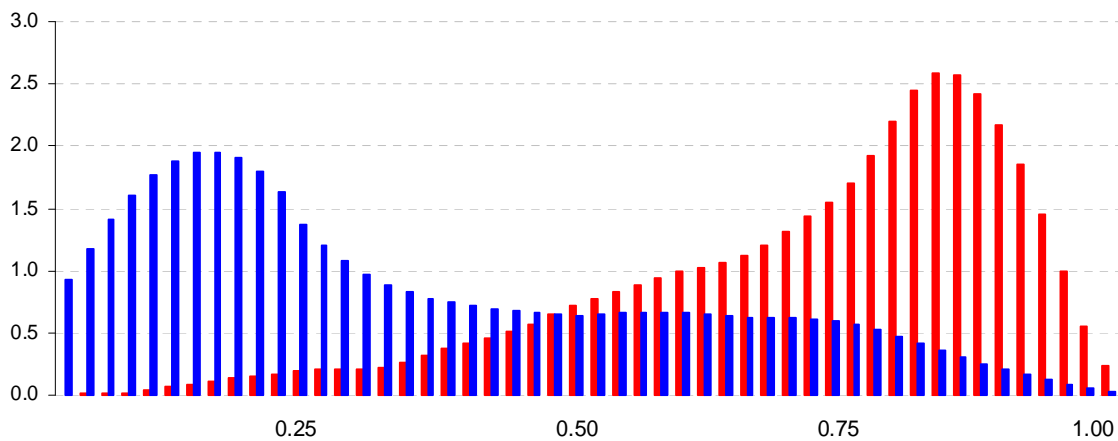
	Beneficiarios		No Beneficiarios	
	Mean	SD	Mean	SD
<i>Superficie Total (1000 has)</i>	<b>0.92</b>	0.62	<b>2.62</b>	2.67
<i>Montevideo=1</i>	<b>0.13</b>	0.34	<b>0.04</b>	0.19
<i>Indice Coneat</i>	<b>91.2</b>	26.1	<b>91.7</b>	27.9
<i>Edad</i>	<b>47.2</b>	10.8	<b>53.7</b>	14.8
<i>Educacion Superior=1</i>	<b>0.05</b>	0.21	<b>0.02</b>	0.13
<i>Tiene Actividad Extrapredial=1</i>	<b>0.43</b>	0.50	<b>0.27</b>	0.44
<i>Recibe Asistencia de Agronomo Priv=1</i>	<b>0.73</b>	0.45	<b>0.91</b>	0.29
<i>Recibe Asistencia de Veterinario Priv=1</i>	<b>0.91</b>	0.28	<b>0.95</b>	0.22
<i>Participo en algun programa MGAP=1</i>	<b>0.23</b>	0.42	<b>0.06</b>	0.24
<i>Revisa los Toros=1</i>	<b>0.26</b>	0.44	<b>0.62</b>	0.49
<i>Reg. Eventos Fisicos=1 (2001)</i>	<b>0.70</b>	0.46	<b>0.69</b>	0.46
<i>Reg. Eventos Fisicos=1 (2003)</i>	<b>0.96</b>	0.18	<b>0.71</b>	0.45
<i>Reg. Eventos Fisicos=1 (Change 2003-2001, %)</i>	<b>26.05</b>	46.60	<b>1.49</b>	48.63
<i>Reg. Eventos Economicos=1 (2001)</i>	<b>0.78</b>	0.41	<b>0.74</b>	0.44
<i>Reg. Eventos Economicos=1 (2003)</i>	<b>0.92</b>	0.27	<b>0.82</b>	0.38
<i>Reg. Eventos Economicos=1 (Change 2003-</i>	<b>13.71</b>	41.36	<b>7.66</b>	42.13
<i>Porcentaje de Destete (2001)</i>	<b>67.02</b>	8.61	<b>65.53</b>	15.95
<i>Porcentaje de Destete (2003)</i>	<b>71.07</b>	9.81	<b>71.31</b>	14.55
<i>Porcentaje de Destete (Change 2003-2001, %)</i>	<b>3.87</b>	11.25	<b>5.41</b>	19.62
<i>PER (2001)</i>	<b>40.10</b>	1.17	<b>50.30</b>	0.47
<i>PER (2003)</i>	<b>43.96</b>	1.14	<b>55.10</b>	0.53
<i>PER (Change 2003-2001, %)</i>	<b>3.65</b>	1.44	<b>4.80</b>	0.64
<i>Realiza Diag. Preñez=1</i>	<b>0.65</b>	0.48	<b>0.53</b>	0.50

Source: Own Elaboration with data from DIEA and UCP from the MGAP.

The differences between the characteristics of beneficiaries and non-beneficiaries are not manifested as a group, but, their relative significance can be evaluated in a discrete logit model. In annex 1, the results of the model's estimations are presented. As a general pattern it is observed that the group of beneficiaries and the control group show statistical similarities in the CONEAT index, percentage of technical assistance from a private veterinary or agronomist, percentage of breeders that keep registries of physical events and the weaning percentage after controlling for other characteristics. Moreover, it is found that the beneficiaries to the project are characterized for being breeders of higher ages at decreasing rates, have a higher percentage with higher levels of education,

have a higher percentage living in Montevideo, have some activity outside the farm, have participated in some of the MGAP's programs before 2001, take a registry of physical events and implement a form of pregnancy diagnosis. Conversely, non-beneficiaries are characterized for having farms of greater size and that do not implement livestock check-ups.<sup>19</sup> The adjustment of the estimation models is high in relation to the adjustments that are commonly used in these types of studies, fluctuating between 39% and 41%. The values of the coefficients and their significance are in light of the different specifications. Indeed, after eliminating the variables that are not significant, the values of the rest of the parameters and the goodness of fit indicator do not experience major modifications. Graph 1 shows that there is an area in which the propensity score of beneficiaries is similar to those of non-beneficiaries and therefore it is possible to use the ATT.

**Graph 1**  
**Propensity Score Density**



Note: to calculate propensity score, we used model 5 reported in Annex.

The previous model allows us to determine the characteristics of the beneficiaries in comparison to the non-beneficiaries. However, it is necessary to categorize producer beneficiaries in terms of their productive orientation: cattle breeding, complete cycle or wintering. For example, the ratio between the numbers of steers older than two years divided by the number of breeding cows is considered. If the ratio is less than 0.2 the farm is said to be oriented towards breeding, if the ratio is between 0.2 and 2 the farm is said to be of a complete cycle, and if the ratio is superior to two, the farm is said to be for wintering.<sup>20</sup>

*Impact Evaluation Results: Management and Productivity Indicators*

<sup>19</sup> It is worth noting that the operations where the check-ups of bulls are implemented have, on average, 2,500 has, compared with 1,100 has in those where these are not implemented.

<sup>20</sup> This classification is commonly used in livestock studies such as in the DIEA-MGAP (2002). "Encuesta Ganadera 2001"

Among the administrative management indicators we can find the percentage of producers that keep physical and economic registries. On the other hand, the indicators for productivity at the level of cattle breeding we can find the percentage of weaning and the percentage of reproductive efficiency. There is still a debate about the scope of the productivity indicators, however, the traditional indicators will be used for equations (3) and (4).

$$\text{Weaning Percentage} = \frac{\textit{Terneros}}{\textit{Vacas de cria}} \quad (3)$$

$$\text{Reproductive Efficiency Parameter (REP)} = \frac{\textit{Terneros}}{\textit{Vacas} \geq 1 \textit{ año}} \quad (4)$$

The weaning percentage and the REP are “average production” indicators that allow for the quantification of the capabilities of a farm to produce calves as a function of the cows that can potentially be bred. The difference between these two measurements is the base of cows that are capable of reproducing calves that each of these two considers. For instance, the weaning percentage considers, exclusively, breeding cows as cows that can potentially be bred. On the other hand, in addition to using breeding cows, the REP uses heifers older than two years old that have not been mated and heifers from 1 to 2 years old as cows that can potentially be bred. The literature suggests that the REP is a better indicator than the weaning percentage when it comes down to determining reproductive efficiency, Rovira (1996), Adler y Murguía (2000), Caputi y Murguía (2003).

The simplest approximation would be to consider the evolution of the indicator for beneficiaries and to subtract it from the non-beneficiaries, as it is done with the DDS indicator in equation (1). For instance, it is observed that the number of beneficiaries in the sample that began to keep registries of economic events during the implementation of the project increased by 13.1 percentage points, while for the group of non-beneficiaries it increased by 7.7 percentage points. As for the variation of registries for physical events, the group of beneficiaries had an increase of 26 percentage points, compared with an increase of only 1.5 percentage points for the control group. In the case of Weaning Percentage the beneficiaries experienced an increase of 3.86 percentage points versus 4.48 percentage points for the control group. Finally, the REP increased by 4.86 percentage points for beneficiaries and 3.24 for non-beneficiaries.<sup>21</sup>

If the impact evaluation is performed according to equation (2) and, considering the complete sample of beneficiaries and non-beneficiaries, it was found that the project contributed to producers beginning to keep registries for physical and economic events, reaching figures of 25 and 18 percentage points, respectively, at the 5% significance level. Likewise, it is observed that the group of beneficiaries and the control group increased their productive indicators for Weaning Percentage and REP, however, it is not possible to confirm that the beneficiaries of the livestock project had significantly greater

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<sup>21</sup> Previous evaluations compare the indicators for beneficiaries versus the population’s average, obtaining a difference of 26 percentage points in the percentage of producers that keep registries of physical events and 8 for the percentage of producers that keep registries for economic events, 5 percentage points for REP. Source: PCR

increases than the control group, at the 10% significance level. The results can be found in Annex 2 – Exercise 1.<sup>22</sup>

The previous results were achieved based on the total number of beneficiaries for whom we had panel data observations, however, the productive orientation of the farms is heterogeneous and thus it is necessary to analyze if the project had an impact for beneficiaries with a productive orientation for cattle breeding or for a complete cycle, excluding the sample of farms dedicated to wintering.<sup>23</sup> The results of this exercise demonstrates that the project contributes to the increase in the percentage of farms that keep registries for physical and economic events, but it does not find that the project contributed to an increase in the productivity indicators in a significant way, and these results are consistent with those obtained from the complete sample.

Following the logic of the previous exercise, the impact of the project is evaluated for the sub-group of farms that had an orientation for cattle breeding between 2001 and 2003. The results reported in Annex 2 – Exercise 2 suggest that for these set of producers the project contributed in a significant manner to increase the percentage of producers that keep economic registries by 22 percentage points and a significant increase is found in the REP of 1.47 percentage points compared to the control group, at the 5% and 10% significance levels, respectively. No significant impacts are found in the increase of registries of physical events or for the weaning percentage.

When repeating the same exercise for farms of complete cycles, as reported in Annex 2 – Exercise 3, it is found that the project contributed by 15.8 percentage points of additional farmers that keep registries of physical events. No significant impacts are found with regards to registries for economic events or for productivity indicators.

The results show that the impact evaluation of the complete sample, at times, hides the impacts of the project for specific groups of breeders. For instance, the impact evaluation for the complete sample does not reflect significant increases in the productivity indicators, while when restricting the sample to farms with an orientation to cattle breeding a positive impact is found. In the same manner, the estimation with the complete sample reveals a positive impact of the project in the increase of the registries for physical and economic events, while when evaluating the impacts considering a sub-sample according to the productive orientation, it is found that only farms with a complete cycle orientation experienced positive increases in the physical events registries

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<sup>22</sup> It is worth noting that different methods were used to calculate the propensity scores and to carry out the matching. In fact, alternative propensity scores were used where various explicative variables were included, such as squared variables, and interactions of the determinants that were considered in the equation of participation. In the same manner, the control groups were constructed on the basis of different techniques: radius matching with calipers of (0.1, 0.05 and 0.01), nearest neighbor with 1, 2, and 3 neighbors, kernel-epanechnikov with bandwidths of (0.04, 0.08 y 0.15). Finally, it was opted to work with the propensity score obtained with model M5 presented in annex 1, and to use the kernel-epanechnikov for the matching. With this choice, the need to balance the characteristics between beneficiaries and the control group, and the need to obtain an acceptable number of observations were reconciled.

<sup>23</sup> The target group for component I is made up of operations for livestock breeding and complete cycle, thus the productivity indicators that are considered are productivity indicators for cattle breeding.

and only the farms with an orientation to cattle breeding experienced significant increases in the registries for economic events.

Considering that the producers with an orientation to cattle breeding increased their REP by 6.67 percentage points, it is interesting to determine the economic value of such said increase. For these purposes, it is important to consider that between 2001 and 2003 the producers increased, on average, their number of cows older than one year from 370 to 426, which represents an increase of 15 percentage points. If one considers that the value of a calf is US\$210 then it can be estimated that the benefits of the project increased their earnings by  $0.0667 \times 370 \times \text{US\$}210 = \text{US\$}5,183$  during 2001 and 2003. However, if the increase in the REP is of a permanent nature and the number of cows older than one year is maintained constant, the increase in annual earnings would be an additional 15%, reaching US\$5,960. Another way of measuring this is to consider their contribution to GDP as intermediate goods. For instance, considering that a standing cow weighs approximately 390 kg. and a steer 475 kg. the average weight is 432kg. Additionally, assuming that the price of a ton of slaughter cattle had a value of US\$1,450 and for the 432kg. one obtains 200 kg. of carcass (54% of output), one would find that the value that each producer contributed to GDP is US\$9,562 or the equivalent of US\$10.6 per hectare.

*Impact Evaluation Result: Mobility in the Productive Orientation*

In table 3 the mobility of the productive orientation can be appreciated for a sample of 617 livestock producers. The first reading of the table, interpreting the aggregate observations, shows that between 2001 and 2003 the percentage of farms with an orientation towards cattle breeding remained at 44%, while the participation of farms for complete cycle remained at 56%. However, the reading of the aggregate data hides the dynamic truth that the farms of the sector actually experienced. For instance, only 44% of producers with a productive orientation for cattle breeding and 63% of producers with an orientation for complete cycle maintained their productive orientation during 2001 and 2003. These patterns of mobility remain when one distinguishes between beneficiaries and non-beneficiaries, even though the beneficiaries show a more active dynamic. This simple exercise reveals the importance of constructing panel data for the Uruguayan agricultural sector, since the aggregate numbers do not permit us to answer the questions related to the inter-seasonal evolution of livestock producers and their farms, to understand the short-term movements in order to design policies based on more precise diagnoses.

**Table 3**  
**Matrix of Transition**  
**Number of Farms based on Productive Orientation**

Muestra Completa

		2003		
		Cria Vacuna	Ciclo Completo	Total
2001	Cria Vacuna	147	125	272
	Ciclo Completo	126	219	345
	Total	273	344	617

Beneficiarios

		2003		
		Cria Vacuna	Ciclo Completo	Total
2001	Cria Vacuna	81	104	185
	Ciclo Completo	100	92	192
	Total	181	196	377

No Beneficiarios

		2003		
		Cria Vacuna	Ciclo Completo	Total
2001	Cria Vacuna	66	21	87
	Ciclo Completo	26	127	153
	Total	92	148	240

Source: Own Elaboration with data from DIEA and UCP of the MGAP.

The results from table 3 give good reason for analyzing the influence of the project on farms that initially had an orientation for a complete cycle and ended up becoming farms for cattle breeding and vice versa. Such said interest is founded on the fact that one of the diagnosed problems in the Uruguayan livestock sector is related to the low levels of specialization in each of the linkages of the production chain, which do not allow for taking advantage of economies of scale and of the environment, as it has been observed in countries with similar comparative advantages.<sup>24</sup>

In order to determine the influence of the project in specialization, the following indicators are constructed:

$$\text{Indicador}_1 = 100 \cdot \frac{|1.1 - r|}{1.1}$$

$$\text{Indicador}_2 = \frac{[100 * (1.1 - r)]^2}{121}$$

$$\text{where } r = \text{Min} \left\{ \frac{\text{Novillos con mas de 2 años}}{\text{Vacas de Cria}}, 2.2 \right\}$$

<sup>24</sup> Loan Document 1299/OC-UR, paragraph 1.4.

These indicators increase as  $r$  gets further away from  $1.1=0.5*(0.2+2)$ . Indicator 1 does it at a constant rate and Indicator 2 does it at an increasing rate (see graphs in annex 3). The numbers suggest that the indicator of specialization increased for beneficiaries and non-beneficiaries; however, the increase experienced by the group of non-beneficiaries exceeds those of the beneficiaries (Annex 4, Exercise 5).

An additional exercise consists on determining the influence of the project on those farms with a complete cycle orientation or a livestock breeding one that increased their specialization in cattle breeding. For these purposes a linear indicator was used and a non-linear one was used as the specialization of cattle breeding increases (see graph in annex 3). The indicators used are the following:

$$\text{Indicator}_3 = 100 - 50r, \quad r \in [0.2, 2]$$

$$\text{Indicator}_4 = 100 - 100r + 25r^2, \quad r \in [0.2, 2]^{25}$$

The results reported in Annex 4-Exercise 6 demonstrate that when considering the group of producers that increased their productive orientation towards breeding experienced an increase in specialization higher than the non-beneficiaries.

Following in line with the previous exercise, one seeks to determine the influence of the project on those farms with a complete cycle orientation or a breeding one that decreased their cattle breeding specialization. For these purposes a linear indicator was used and a non-linear one on the ratio of “ $r$ ”. The indicators used are the following:

$$\text{Indicator}_5 = 50r, \quad r \in [0.2, 2]$$

$$\text{Indicator}_6 = 25r^2, \quad r \in [0.2, 2]^{26}$$

The results reported in Annex 4-Exercise 7 demonstrate that for the sub-group of producers that decreased their productive orientation in the area of breeding, no significant differences between beneficiaries and non-beneficiaries were found.

The balance tables reported in the annex demonstrate that the methodology contributes to the reduction of biases in the observable characteristics that differentiate beneficiaries from non-beneficiaries.

#### *Impact Evaluation Result: Effects Associated to the Intensity of the Subsidy*

This section wishes to analyze if there exist incremental effects on the productivity indicators associated with the petition for subsidies of higher value. Graph 2 presents the distribution of the solicited subsidies. As an exploratory analysis a regression was implemented considering as dependent variables the variations of the productivity indicators, the REP and the weaning percentage, for 2001 and 2003. Such said indicators are justified due to the amount of subsidy that was requested, and one controls for the characteristics of the property, of the producer, and of the implementations. It is found

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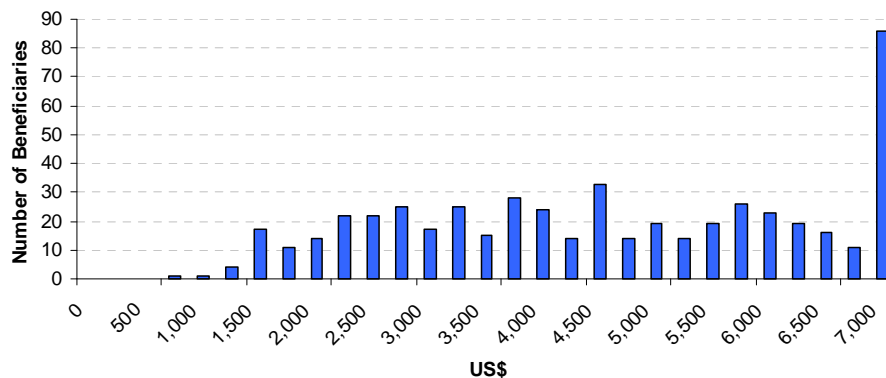
<sup>25</sup> It is important to note that the parameters for the quadratic function were selected arbitrarily with the purpose that the indicator be non-linear and decreasing at growing rates in  $r$  for the range of values of  $r$  in which the indicator is defined.

<sup>26</sup> Indicators 4 and 6 have a slope of zero when the indicator is zero and a slope of 100 when the indicator is 100.

that the subsidy has a positive and significant effect on the weaning percentage when one considers the complete sample, that is, beneficiaries and non-beneficiaries. For the case where the sample is restricted to only beneficiaries of the project, the parameter associated with the subsidy turns out to be not significant. Annex 6 presents the results. In the case of Weaning Percentage, in neither of the cases mentioned previously, is found that the coefficients associated with the amount of solicited subsidy are significant.

This analysis can present omitted variable biases or of specification, thus, an ad hoc regression is postulated. In order to overcome this difficulty, an extension of the Propensity Score Matching method described in the methodology is utilized.<sup>27</sup> For these purposes, beneficiaries are separated into two groups, separating those that solicited a subsidy greater than US\$4,000 (T=1) versus those that solicited a lower subsidy (T=0)<sup>28</sup>. A logit model of probability is estimated (see annex 7) and the propensity scores are calculated. Using these scores, one calculates the effect of increasing the amount of solicited subsidy, and it is found that there are no differentiated effects on the productivity indicators and of administrative management indicators for beneficiaries and non-beneficiaries to the project.

**Graph 2**  
**Distribution of the Solicited Subsidies**



The previous analysis arises from a policy interest more than from an impartial criterion. In order to approach this problems a cluster analysis is used to separate beneficiaries of the project into “k” groups organized according to the amount of solicited subsidy, considering k=2, 3, and 4. In order to determine categorization of beneficiaries into each group based on proceeds a cluster analysis is used, with the K-means method. Table 1 presents the descriptive statistics of the received subsidies for each group. Subsequently, 4 equations of participation are estimated based on a logit equation, for k=2 and, an ordinal logit for k=3 and 4. These equations, which are presented in annex 7, were obtained from an estimation implemented with all the available variables and the

<sup>27</sup> See Imbens (2000) for a discussion of the methodology.

<sup>28</sup> This cut-off point is of interest, because the new version of the project gives a maximum subsidy of US\$4,000.

non-significant ones were eliminated subsequently, this, without reducing in a significant fashion the goodness of fit of the model. Finally, the impact associated with soliciting higher levels of subsidy are evaluated, considering  $k=2, 3, \text{ and } 4$ . In each case the group that solicited a smaller subsidy was used as the control group, while the groups with higher subsidies were used as the treatment group.

The results, which are reported in annex 7, suggest that there are no increasing effects associated with higher levels of solicited subsidies. This result is consistent when dividing beneficiaries into groups 2, 3, and 4, according to their earnings. Consequently, the parametric and non-parametric analysis suggests that there are no incremental benefits when higher levels of subsidies are solicited.

## **6. Conclusions and Recommendations**

The aim of this paper was to evaluate the impact of the LPP on management, productivity and specialization indicators. For this purpose, we used 2001 and 2003 data from Livestock Survey (DIEA-MGAP) and Project Coordination Unit (UCP) to set up a unique panel dataset, generating a unique panel dataset of 990 observations, 520 for beneficiaries and 470 for non beneficiaries.

Descriptive statistics shows that the characteristics associated with the beneficiaries and non-beneficiaries present significant differences. This justifies the implementation of traditional methods of impact evaluation that allow for the construction of a control group that can control for these slants.

Drawing on this unique dataset, we estimated the LPP's impacts adopting a difference-in-difference with propensity score matching estimation strategy. These estimation techniques allowed us to minimize the effect of selection biases by identifying balanced treated and control samples of producers and by controlling for time-invariant unobservable covariates.

The first stage of the matching procedure allowed us to detect significant differences between the treated and the non-treated group. We were able to define a participation model that is robust in different specifications and it is explained by producers' characteristics, of the farm, and of implementation. As a general pattern, we found that project beneficiaries are characterized for being breeders that have smaller land extensions, that have previously participated in at least one of the MGAP's programs, that have a higher percentage that keep registries of economic events, that have a higher percentage doing pregnancy diagnosis and that have a smaller percentage that carry out bull check-ups. Testing after the matching, we found that the selected and treated groups were balanced in all the relevant covariates.

The results of the impact evaluation show that the project positively affected the rate of adoption of management practices, such as keeping record of physical and economic events. Our results also show that the project positively affected the productivity of the livestock producers specialized in the breeding stage. In particular, we found that the Reproductive Efficiency Index (REI) of the beneficiary breeders is 6.7 percentage points higher than the REI of the non-beneficiaries. In economic terms, this result means an

average income increase of US\$5,960 for the beneficiaries. These results notwithstanding, we found that the project is only partially successful in fostering the breeders' rate of specialization, probably due to a still too high risk aversion towards complete specialization.

We found that there was an increasing mobility in the productive orientation of producers during 2001 and 2003. The results indicate that, for the complete sample, the project did not have influence in such said movements in the productive orientation. However, we found that for the sub-group of producers that modified their productive orientation towards cattle breeding, project beneficiaries did this with a higher intensity.

Finally, we found that there were no differential effects in the productive indicators associated with the intensity of the solicited subsidy for each beneficiary. This result is robust by utilizing parametric and non-parametric techniques. Nevertheless, this result does not allow inferring if there is a differentiated effect for subsidies higher than US\$7,000.

Potential extension of this study would need additional data. To date, significant efforts have been made to collect microdata in 2001 and 2003, which facilitated the understanding of important aspects of the Uruguayan livestock sector. However, the construction of a longer panel dataset would allow to identify if project beneficiaries adopted better practices on a permanent or temporary basis. In the same manner, it would be possible to determine the long-term effects on the productivity indicators and thus obtain important lessons for the new livestock project that is being implemented.

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## Annex 1

### Logit Estimations for the Determinants of Project Participation

	M1	M2	M3	M4	M5
<i>Superficie Total</i> (1000 has)	-1.231**	-0.993**	-0.961**	-0.964**	-0.957**
<i>Montevideo=1</i>	2.183	0.576	0.674*	0.661*	0.688*
<i>Indice Coneat</i>	-0.003	-0.003	-0.003	-0.003	
<i>Edad</i>	0.044	0.133**	0.139**	0.141**	0.137**
<i>Edad<sup>2</sup></i>	-0.001	-0.002**	-0.002**	-0.002**	-0.002**
<i>Educacion Superior=1</i>		2.131**	1.617*	1.631*	1.614*
<i>Tiene Actividad Extrapredial=1</i>	0.463	0.433*	0.364*	0.377*	0.378*
<i>Recibe Asistencia de Agronomo Priv=1</i>	-0.668				
<i>Recibe Asistencia de Veterinario Priv=1</i>	0.849				
<i>Participo en algun programa MGAP=1</i>	1.466**	1.323**	1.225**	1.218**	1.229**
<i>Revisa los Toros=1</i>	-1.378**	-1.812**	-1.756**	-1.776**	-1.771**
<i>Reg. Eventos Fisicos=1</i> (2001)	-0.348	-0.125	-0.11		
<i>Reg. Eventos Economicos=1</i> (2001)	-0.07	1.081**	0.98**	0.939**	0.88**
<i>Porcentaje de Destete</i> (2001)	0.014	-0.003			
<i>Realiza Diag. Preñez=1</i>	1.229**	1.343**	1.312**	1.297**	1.308**
<i>Constante</i>	2.217	-1.37	-1.717	-1.776	-1.894
<b>Observaciones</b>	339	708	734	736	744
<b>Wald Chi2</b>	99.5	189.9	184.1	184.7	184.9
<b>PseudoR2</b>	0.52	0.41	0.39	0.39	0.39

Fuente: Elaboracion propia en base a informacion disponible de DIEA y UCP del Programa Ganadero

Los Errores Estandar fueron estimados considerando heteroscedasticidad desconocida en los residuos del modelo.

\*\*, \* Indican que el coeficiente estimado es estadísticamente significativo al 5% y 10% respectivamente.

## Annex 2

### Impact Evaluation for Administrative Management and Productivity Indicators

#### Impact Evaluation (Exercise 1, in percentage points)

		Explotaciones de Cria y Ciclo Completo				
		Beneficiarios	No Beneficiarios	Impact	Common Support	
		Change 2003-2001	Change 2003-2001		treated	untreated
<i>Registro de Eventos Fisicos</i>	unmatched	25.63	0.58	25.05		
	ATT	25.63	0.35	<b>25.29**</b>	394	270
<i>Registro de Eventos Economicos</i>	unmatched	12.44	8.43	4.01		
	ATT	12.44	-6.30	<b>18.74**</b>	394	270
<i>Porcentaje de Destete</i>	unmatched	3.86	4.48	-0.61		
	ATT	3.22	6.55	-3.33	253	114
<i>PER</i>	unmatched	4.86	3.24	1.63		
	ATT	4.44	2.69	1.75	253	95

Fuente: Elaboracion Propia

Cifras obtenidas utilizando el metodo de Propensity Score Matching (Kernel-Epanechnikov y bandwidth de 0.08)

\*\*, \* Significativo al 5% y 10% respectivamente, test de una cola. Los errores estandar se estimaron con bootstrap con 500 iteraciones.

### Impact Evaluation (Exercise 2, in percentage points)

Explotaciones de Cria						
		Beneficiarios	No Beneficiarios	Impact	Common support	
		Change 2003-2001	Change 2003-2001		treated	untreated
<i>Registro de Eventos Fisicos</i>	unmatched	27.27	3.57	23.70		
	ATT	29.31	25.75	3.56	58	30
<i>Registro de Eventos Economicos</i>	unmatched	19.70	10.71	8.98		
	ATT	20.69	-2.12	<b>22.81**</b>	58	30
<i>Porcentaje de Destete</i>	unmatched	3.31	-0.69	4.00		
	ATT	1.55	1.41	0.15	34	19
<i>PER</i>	unmatched	3.72	-1.43	5.15		
	ATT	1.71	-4.96	<b>6.67*</b>	34	17

Fuente: Elaboracion Propia

Cifras obtenidas utilizando el metodo de Propensity Score Matching (Kernel-Epanechnikov y bandwith de 0.08)

\*\* , \* Significativo al 5% y 10% respectivamente, test de una cola. Los errores estandar se estimaron con bootstrap con 500 iteraciones.

### Impact Evaluation (Exercise 3, in percentage points)

Explotaciones de Ciclo Completo						
		Beneficiarios	No Beneficiarios	Impact	Common support	
		Change 2003-2001	Change 2003-2001		treated	untreated
<i>Registro de Eventos Fisicos</i>	unmatched	14.93	6.54	8.38		
	ATT	18.75	2.98	<b>15.77*</b>	48	72
<i>Registro de Eventos Economicos</i>	unmatched	7.35	13.08	-5.73		
	ATT	10.20	5.28	4.92	49	72
<i>Porcentaje de Destete</i>	unmatched	5.21	5.78	-0.57		
	ATT	3.43	10.90	-7.47	46	60
<i>PER</i>	unmatched	7.45	4.64	2.82		
	ATT	6.37	5.73	0.64	46	52

Fuente: Elaboracion Propia

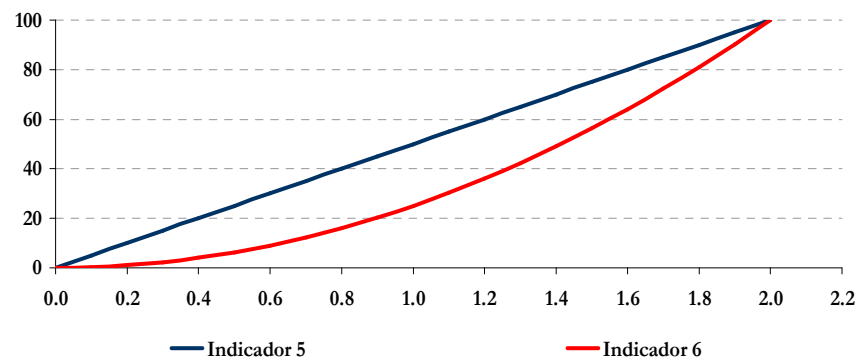
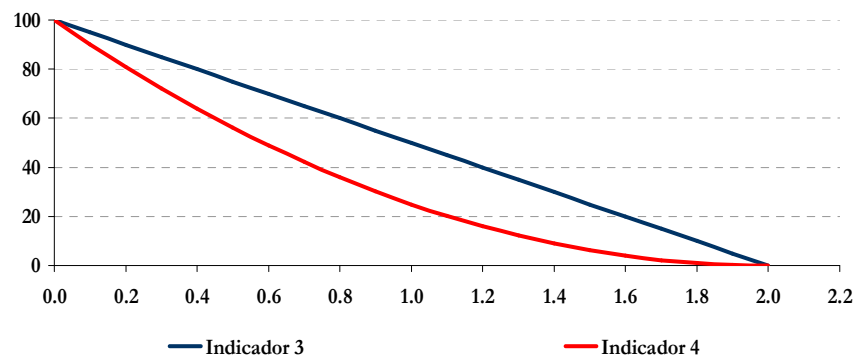
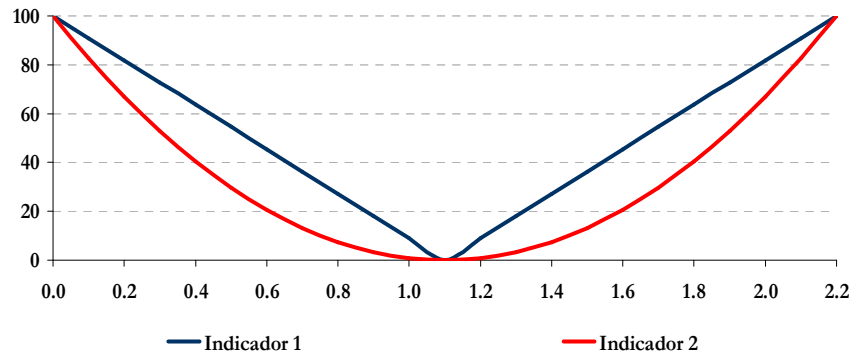
Cifras obtenidas utilizando el metodo de Propensity Score Matching (Kernel-Epanechnikov y bandwith de 0.08)

\*\* , \* Significativo al 5% y 10% respectivamente, test de una cola. Los errores estandar se estimaron con bootstrap con 500 iteraciones.

### Annex 3

## Specialization Indicators

Graphical Representation of Specialization and Mobility Indicators



## Annex 4

### Impact Evaluation of Mobility Indicators

#### Impact Evaluation (Exercise 5)

Indicador 1

	2001	2003	2003-2001
Treated	74.2	79.7	5.4
Control	72.3	86.3	14.0
ATT			-8.6**

Indicador 2

	2001	2003	2003-2001
Treated	62.5	70.7	8.2
Control	58.5	80.6	22.1
ATT			-13.9**

Nota: El grupo de soporte utilizado incluye 400 beneficiarios y 270 no beneficiarios.

#### Impact Evaluation (Exercise 6)

Indicador 3

	2001	2003	2003-2001
Treated	72.6	98.5	25.9
Control	79.5	98.1	18.5
ATT			7.3**

Indicador 4

	2001	2003	2003-2001
Treated	54.4	97.0	42.6
Control	63.9	96.2	32.3
ATT			10.3**

Nota: El grupo de soporte utilizado incluye 63 beneficiarios y 16 no beneficiarios.

#### Impact Evaluation (Exercise 7)

Indicador 5

	2001	2003	2003-2001
Treated	2.1	34.2	32.0
Control	1.6	37.1	35.6
ATT			-3.5

Indicador 6

	2001	2003	2003-2001
Treated	0.1	15.6	15.4
Control	0.1	18.7	18.6
ATT			-3.2

Nota: El grupo de soporte utilizado incluye 30 beneficiarios y 8 no beneficiarios.

## Annex 5

### Table of Balance of the Impact Evaluation (Exercise 1)

Variable	Sample	Mean		%bias	% reduction	t	p-value
		Treated	Control				
<i>Superficie Total (1000 has)</i>	Unmatched	0.92	2.68	-88.7		-12.40	0.00
	Matched	0.92	0.80	6.3	92.8	9.58	0.00
<i>Montevideo=1</i>	Unmatched	0.13	0.04	33.6		4.48	0.00
	Matched	0.13	0.21	-25.8	23.3	-5.23	0.00
<i>Indice Coneat</i>	Unmatched	89.95	89.54	1.5		0.20	0.84
	Matched	89.95	90.20	-0.9	39.1	-3.09	0.00
<i>Edad</i>	Unmatched	47.02	53.94	-53.9		-7.38	0.00
	Matched	47.02	46.22	6.2	88.5	6.17	0.00
<i>Edad2</i>	Unmatched	2328.3	3121.1	-57.9		-7.96	0.00
	Matched	2328.3	2246.6	6	89.7	6.78	0.00
<i>Educacion Superior=1</i>	Unmatched	0.06	0.01	22.5		3.00	0.00
	Matched	0.06	0.05	3.2	85.9	-1.63	0.10
<i>Tiene Actividad Extrapredial=1</i>	Unmatched	0.42	0.26	35.5		4.79	0.00
	Matched	0.42	0.50	-17	52.1	-5.34	0.00
<i>Recibe Asistencia de Agronomo Priv=1</i>	Unmatched	0.72	0.89	-44.2		-3.83	0.00
	Matched	0.72	0.80	-18.9	57.3	-1.09	0.28
<i>Recibe Asistencia de Veterinario Priv=1</i>	Unmatched	0.91	0.95	-19.1		-2.05	0.04
	Matched	0.91	0.89	5.5	71.2	1.40	0.16
<i>Participo en algun programa MGAP=1</i>	Unmatched	0.25	0.06	54.8		7.30	0.00
	Matched	0.25	0.20	16.2	70.4	-4.47	0.00
<i>Revisa los Toros=1</i>	Unmatched	0.26	0.62	-77.8		-10.58	0.00
	Matched	0.26	0.37	-23	70.5	4.98	0.00
<i>Reg. Eventos Fisicos=1 (2001)</i>	Unmatched	0.71	0.71	-0.8		-0.11	0.91
	Matched	0.71	0.65	13.1	-1509.2	0.84	0.40
<i>Reg. Eventos Economicos=1 (2001)</i>	Unmatched	0.79	0.73	13.4		1.82	0.07
	Matched	0.79	0.72	14.7	-9.7	-0.28	0.78
<i>Porcentaje de Destete (2001)</i>	Unmatched	66.73	66.07	5.2		0.71	0.48
	Matched	66.73	67.98	-9.9	-90.7	-1.61	0.11
<i>Realiza Diag. Preñez=1</i>	Unmatched	0.62	0.52	20		2.71	0.01
	Matched	0.62	0.60	5.1	74.5	-3.51	0.00

Fuente: Elaboración Propia en base a la estimación logit del modelo 5 del anexo 1

## Annex 6

### Determinants of the Changes in Reproductive Efficiency: REP

	Muestra Completa	Common Support	Solo Beneficiarios	Beneficiarios y Common Support
Subsidio (MUS\$)	0.90**	0.86**	-0.69	0.31
Superficie (1000 has)	-0.20	-1.48**	0.07*	0.07*
Montevideo (=1)	1.47	1.36	2.28	2.28
Experiencia (años)	0.09	0.17	-0.15	-0.15
Exp2	0.00	0.00	0.00	0.00
Educacion Superior =1	2.93	3.34	2.51	2.51
Act. Fuera del Predio=1	1.27	1.19	0.83	0.83
Beneficiario MGAP antiguo =1	3.32**	3.09**	1.34	1.34
Revisa el rodeo =1	0.30	0.26	0.57	0.57
Registro Eventos Fisicos=1	1.44	1.72	0.23	0.23
Realiza Diagnostico de Prenez=1	0.43	0.97	-0.45	-0.45
PER (2001)	-0.69**	-0.66**	-0.82**	-0.82**
Porcentaje de Destete (2001)	-0.09	-0.08	-0.86	0.14
Constante	35.63**	32.66**	39.55**	39.55**
R2	0.33	0.29	0.32	0.32
Obs.	504	468	373	373
F-Stat	17.4	13.5	13.7	13.7

### Determinants of the Changes in Reproductive Efficiency: Weaning Percentage

	Muestra Completa	Common Support	Solo Beneficiarios	Beneficiarios y Common Support
Subsidio (MUS\$)	-0.23	-0.16	0.15	0.29
Superficie (1000 has)	-0.08	-1.53*	-1.85*	-2.65**
Montevideo (=1)	1.71	1.86	1.82	1.90
Experiencia (años)	-0.13	0.07	0.29	0.27
Exp2	0.00	0.00	0.00	0.00
Educacion Superior =1	0.95	1.57	1.98	2.36
Act. Fuera del Predio=1	1.12	1.10	0.56	0.47
Beneficiario MGAP antiguo =1	1.29	1.13	1.27	1.35
Revisa el rodeo =1	1.55	1.83	1.57	1.59
Registro Eventos Economicos=1	2.29*	2.00	1.34	1.28
Realiza Diagnostico de Prenez=1	0.54	0.80	0.90	1.03
PER (2001)	0.03	0.01	0.00	0.00
Porcentaje de Destete (2001)	-0.82**	-0.80**	-0.68**	-0.69**
Constante	56.79**	52.98**	40.64**	41.32**
R2	0.38	0.36	0.25	0.25
Obs.	513	474	373	369
F-Stat	20.6	17.2	11.6	11.4

## Annex 7

### Dosage Analysis

Logistic regression                      Number of obs = 373  
 LR chi2(16) = 193.34  
 Prob > chi2 = 0.0000  
 Log likelihood = -158.90283              Pseudo R2 = 0.3783

	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
suptot	55.51875	21.13833	2.63	0.009	14.08838	96.94912
suptot2	-69.19332	33.89634	-2.04	0.041	-135.6289	-2.757714
suptot3	42.90042	24.66079	1.74	0.082	-5.433836	91.23467
suptot4	-12.88503	8.208085	-1.57	0.116	-28.97258	3.202524
suptot5	1.476193	1.011355	1.46	0.144	-.5060271	3.458412
mvideo	-.1197108	.4166489	-0.29	0.774	-.9363277	.6969061
edad	.2251354	.0864611	2.60	0.009	.0556748	.3945961
edad2	-.0022086	.0008882	-2.49	0.013	-.0039495	-.0004677
edusup	.136304	.6721122	0.20	0.839	-1.181012	1.45362
actfuera	.2203084	.302168	0.73	0.466	-.37193	.8125468
bmgap01	-.2414678	.3327174	-0.73	0.468	-.8935818	.4106462
revisa01	.2142161	.3452258	0.62	0.535	-.4624141	.8908463
eventeco01	-.1557702	.3759795	-0.41	0.679	-.8926764	.5811361
diagprenhez01	.2188368	.3281798	0.67	0.505	-.4243837	.8620574
pdestete01	-.0767374	.0249107	-3.08	0.002	-.1255614	-.0279134
perini	.0341659	.0179262	1.91	0.057	-.0009688	.0693006
_cons	-18.38476	5.306132	-3.46	0.001	-28.78458	-7.984929

### Impact Evaluation of Subsidy > US\$4,000

		Beneficiarios	No Beneficiarios	Impact
		Change 2003-2001	Change 2003-2001	
<i>Registro de Eventos Físicos</i>	unmatched	26.21	24.84	1.37
	ATT	25.82	23.19	2.63
<i>Registro de Eventos Económicos</i>	unmatched	13.94	11.32	2.62
	ATT	13.04	9.44	2.63
<i>Porcentaje de Destete</i>	unmatched	4.09	3.57	0.52
	ATT	3.82	2.50	1.32
<i>PER</i>	unmatched	4.31	5.58	-1.27
	ATT	4.41	6.29	-1.88

Fuente: Elaboracion Propia

Cifras obtenidas utilizando el metodo de Propensity Score Matching (Kernel-Epanechnikov y bandwith de 0.08)

\*\* , \* Significativo al 5% y 10% respectivamente, test de una cola. Los errores estandar se estimaron con bootstrap con 500 iteraciones.

## Grouping of Beneficiaries According the Amount of Subsidy Solicited

4 Groups					
Group	Obs	Mean	SD	Min	Max
0	106	1,990	453	643	2,683
1	127	3,390	418	2,700	4,131
2	133	4,941	504	4,176	5,760
3	154	6,634	437	5,790	7,000

3 Groups					
Group	Obs	Mean	SD	Min	Max
0	166	2,356	618	643	3,286
1	158	4,269	538	3,332	5,294
2	196	6,402	592	5,363	7,000

2 Groups					
Group	Obs	Mean	SD	Min	Max
0	278	3,014	960	643	4,560
1	242	6,126	786	4,621	7,000

Source: Obtained from cluster Analysis K-Means using the euclidean distance as similarity measure.



**Table 3**  
**Impact Evaluation Considering k=4 Groups**

<b>Dosage 01</b>				
		<b>Beneficiarios</b>	<b>No Beneficiarios</b>	<b>Impact</b>
		<b>Change 2003-2001</b>	<b>Change 2003-2001</b>	
<i>Registro de Eventos Fisicos</i>	unmatched	28.83	21.18	7.65
	ATT	28.83	40.07	-11.24
<i>Registro de Eventos Economicos</i>	unmatched	13.89	9.52	4.37
	ATT	13.89	8.72	5.17
<i>Porcentaje de Destete</i>	unmatched	4.60	3.23	1.37
	ATT	4.60	5.15	-0.55
<i>PER</i>	unmatched	6.71	4.70	2.01
	ATT	6.71	5.55	1.17

Fuente: Elaboracion Propia

Cifras obtenidas utilizando el metodo de Propensity Score Matching (Kernel-Epanechnikov y bandwidth de 0.08)

\*\*, \* Significativo al 5% y 10% respectivamente, test de una cola. Los errores estandar se estimaron con bootstrap con 500 iteraciones.

<b>Dosage 02</b>				
		<b>Beneficiarios</b>	<b>No Beneficiarios</b>	<b>Impact</b>
		<b>Change 2003-2001</b>	<b>Change 2003-2001</b>	
<i>Registro de Eventos Fisicos</i>	unmatched	31.36	21.18	10.18
	ATT	31.62	29.19	2.44
<i>Registro de Eventos Economicos</i>	unmatched	15.13	9.52	5.60
	ATT	15.25	13.28	1.98
<i>Porcentaje de Destete</i>	unmatched	5.07	3.23	1.84
	ATT	5.09	5.92	-0.83
<i>PER</i>	unmatched	4.67	4.70	-0.03
	ATT	4.69	4.75	-0.07

Fuente: Elaboracion Propia

Cifras obtenidas utilizando el metodo de Propensity Score Matching (Kernel-Epanechnikov y bandwidth de 0.08)

\*\*, \* Significativo al 5% y 10% respectivamente, test de una cola. Los errores estandar se estimaron con bootstrap con 500 iteraciones.

<b>Dosage 03</b>				
		<b>Beneficiarios</b>	<b>No Beneficiarios</b>	<b>Impact</b>
		<b>Change 2003-2001</b>	<b>Change 2003-2001</b>	
<i>Registro de Eventos Fisicos</i>	unmatched	21.17	21.18	-0.01
	ATT	21.85	16.27	5.58
<i>Registro de Eventos Economicos</i>	unmatched	14.49	9.52	4.97
	ATT	15.97	9.38	6.58
<i>Porcentaje de Destete</i>	unmatched	3.46	3.23	0.23
	ATT	3.72	3.07	0.65
<i>PER</i>	unmatched	3.34	4.70	-1.36
	ATT	2.87	5.17	-2.30

Fuente: Elaboracion Propia

Cifras obtenidas utilizando el metodo de Propensity Score Matching (Kernel-Epanechnikov y bandwidth de 0.08)

\*\*, \* Significativo al 5% y 10% respectivamente, test de una cola. Los errores estandar se estimaron con bootstrap con 500 iteraciones.

### Impact Evaluation Considering k=3 Groups

<b>Dosage 01</b>				
		Beneficiarios	No Beneficiarios	Impact
		Change 2003-2001	Change 2003-2001	
<i>Registro de Eventos Fisicos</i>	unmatched	28.83	21.18	7.65
	ATT	28.83	40.07	-11.24
<i>Registro de Eventos Economicos</i>	unmatched	13.89	9.52	4.37
	ATT	13.89	8.72	5.17
<i>Porcentaje de Destete</i>	unmatched	4.60	3.23	1.37
	ATT	4.60	5.15	-0.55
<i>PER</i>	unmatched	6.71	4.70	2.01
	ATT	6.71	5.55	1.17

Fuente: Elaboracion Propia

Cifras obtenidas utilizando el metodo de Propensity Score Matching (Kernel-Epanechnikov y bandwidth de 0.08)

\*\* , \* Significativo al 5% y 10% respectivamente, test de una cola. Los errores estandar se estimaron con bootstrap con 500 iteraciones.

<b>Dosage02</b>				
		Beneficiarios	No Beneficiarios	Impact
		Change 2003-2001	Change 2003-2001	
<i>Registro de Eventos Fisicos</i>	unmatched	31.36	21.18	10.18
	ATT	31.62	29.19	2.44
<i>Registro de Eventos Economicos</i>	unmatched	15.13	9.52	5.60
	ATT	15.25	13.28	1.98
<i>Porcentaje de Destete</i>	unmatched	5.07	3.23	1.84
	ATT	5.09	5.92	-0.83
<i>PER</i>	unmatched	4.67	4.70	-0.03
	ATT	4.69	4.75	-0.07

Fuente: Elaboracion Propia

Cifras obtenidas utilizando el metodo de Propensity Score Matching (Kernel-Epanechnikov y bandwidth de 0.08)

\*\* , \* Significativo al 5% y 10% respectivamente, test de una cola. Los errores estandar se estimaron con bootstrap con 500 iteraciones.