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ABSTRACT

In this paper, we analyzed the effectiveness of the Component 1 of the Livestock Pilot Project (LPP-1) in fostering the efficiency of the Uruguayan livestock producers. We found that the LPP-1 had an overall positive impact on the adoption of managerial practices, but it had not significant impact on both productivity and specialization. We found positive effects of the LPP-1 also on productivity when we restricted the analysis to the sub-sample of producers specialized in the breeding stage. We also 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-1 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 LPP's Coordinating Unit.

JEL Codes: Q12, Q16, H43

KEYWORDS: Technology Adoption, Productivity, Livestock Sector, Policy Evaluation.

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. However, 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 (IDB), 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 provided matching-grants to finance innovation project designed and developed by Uruguayan producers.

This paper reports the results of the impact evaluation of the Component 1 of the LPP (LPP-1) 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, but it had not significant impact on both productivity and specialization. We found some evidence that the project could have positively affected the productivity of the livestock producers specialized in the breeding stage, though this result is based on a rather small sub-sample of the database. 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. We also 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 clusters of beneficiaries grouped by the amount of subsidy received. This particular extension of the analysis aimed at testing the hypothesis of potential "dosage effects" of

the 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 collected by the Department of Agricultural Statistics of Uruguay (DIEA) and data from the Project Coordination Unit (PCU) 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 differences at producer and farm level between beneficiary and control groups.

Drawing on this unique dataset, we estimated the project impacts adopting a difference-in-difference with propensity score matching estimation strategy. This technique 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 differences between the treated and control groups were significantly reduced in 12 out of the 15 variables and the remaining three do not exhibit a significant difference despite its bias increased.

Following this introduction, this paper is 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-1. Section 4 presents the research hypothesis, discusses the methodology and describes the data used. Section 5 discusses the main findings and section 6 concludes.

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%, thus, giving the agricultural sector a contribution of 14.4% of GDP. 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, while the value of bovine exports increased from US$369 to US$765 million.[1]

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 were 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 (DIEA 2002) shows that a 57% of farmers received some technical assistance but it was temporary for 57% of them; 60% of farmers carried out some review of reproductive ability of bulls and 32% did some pregnancy diagnosis, relations which positively associated with the size of the farm. With reference to the management of farms, the data shows that a 62% of farmers kept a registry of physical or economic events, and 69% of those kept their registries manually. The survey also shows a high heterogeneity of producers'

[1] Sources: DIEA-MGAP (2002), INE (www.ine.gub.uy) and Central Bank of Uruguay (www.bcu.gub.uy/).

characteristics, adopted techniques and practices. This heterogeneity was also reflected in disparities in the productivity indicators. Explanations for this phenomenon were found in two main causes: first, the modes of articulation of the production chain, modes that did not facilitate specialization; second, the low productive management levels of small-scale producers, who had not the opportunity to participate in the learning processes and technological changes as in other countries (IDB 2001).

In this context and after a series of attempts, the Uruguayan Government decided to experiment a new policy approach to the problems of the livestock sector. For this purpose LPP was launched in 2001 with the aim of promoting innovation at various level of the livestock production chain, with particular attention to the breeding-stage.

At the time when the LPP was designed, the lack of efficiency and specialization of more than 50,000 breeders were considered among the main obstacles to any further improvement of the livestock competitiveness. The public authorities were particularly concerned about by the fact that the Uruguayan producers were distributed among the breeding, feeding and finishing stages with a lower degree of specialization than in other competitor countries. The breeders, in particular, tended to always maintain a certain level of activity in the three production stages, even when the quality of their soil was unsuitable to these multiple tasks. This lack of specialization resulted in higher production costs for the entire chain and a significant loss in terms of international competitiveness.

The implementation of the LPP, during 2001-2003, 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, which went 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 with vaccination status (IDB 2001). The international prices for meat returned to 2000 levels, as well as the production and slaughtering rate of cattle.

PILOT PROJECT FOR THE LIVESTOCK SECTOR 2001-2003

The main objective of the LPP 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" (IDB, 2001). To reach this objective, the project was formulated with a base of three components geared to promote innovations at the breeding stage (Component 1), in linkage of the production chain (Component 2), and in commercialization of new products and access to new markets (Component 3). In this paper, we focused on the project's component 1, because components 2 and 3 lacked the necessary information to conduct any impact evaluation.[2]

The purpose of the Component 1 of the LPP (LPP-1) was to promote "innovations in production management at the breeding stage, including the preparation and execution of innovative business plans presented by producers themselves in order to increase the competitiveness of sheep- and cattle-breeding". The adoption of these innovations should have eventually increased the productivity and profitability of the breeding activities.[3]

According to the LPP original design, the eligibility criteria to participate in component 1 were the following:

[2] The LPP did not produce any baseline information on individual characteristics, property or management indicators the beneficiaries of components II and III. This lack of information makes almost impossible the implementation of any standard impact evaluation technique.

[3] It is clear that the causal chain that leads from innovation to efficiency and then profitability assumes that the innovative beneficiaries are able to fully appropriate of the benefit of their innovation. Section 3 discusses this assumption in the case of the LPP-1.

- The size of the beneficiaries' farm should be within the range of 300 and 1,250 CONEAT-100[4] 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 LPP-1 had the opportunity of getting a subsidy of US$7 per hectare, with a ceiling of US$7,000[5]. These resources allowed for the financing of 25% of eligible expenses reported in the business plan submitted to the Project Coordinating Unit (PCU) through facilitators. Eligible expenses of the business plan included expenses for pasture improvement, services and materials, technical assistance and the remuneration of facilitators, with a ceiling of 10% of subsidy received by beneficiaries. 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 innovation projects could have a maximum duration of two years, during which the producers had to implement their business plans. The results of the projects had to be verifiable at the end of the first and second years, to allow the disbursement of the subsidy. This feature created a framework where the development of business plans that incorporate biological processes or of soil improvement and that required longer periods to attain results, had less probability of obtaining the benefits of

[4] CONEAT is an indicator of productive capacity of the soil established by the National Commission of Agroeconomic Land Studies. CONEAT-100 is the average quality level of the soils in the country.

[5] To make a sense of the magnitude of the subsidy, one could consider that 1 ton of exported meat has a value of US$1,450. The maximum amount of the subsidy, US$7/ha, represented between 1% and 8% of annual earnings of livestock exploitations per hectare, according to the figures of income from the livestock survey of 2001.

the subsidy and, therefore, also had a less probability to be proposed by the beneficiaries.

The implementation of the LPP began with an open call to private agents to participate as facilitators. These facilitators were the main counter-part to the PCU, which monitored them through periodical independent audits. They were responsible for supervising the preparation of business plans and, and once the business plans were approved, for verifying the attainment of the objectives required for the disbursements. 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 eventually selected.

Eventually, 93% of business plans were executed satisfactorily, fulfilling at least 70% of intended goals. The average subsidy actually granted was between US$3,500 and US$4,500 for 75% of project beneficiaries.[6] 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 PCU's estimates, the costs of component 1 reached US$3.99 million.

Regarding the administration of the LPP, the PCU relied on an information system especially designed to capture and monitor beneficiaries' information in real time. This allowed setting up a baseline, carrying out an informed administrative process, and monitoring the agreed upon indicators that allowed for a rather satisfactory permanent self-evaluation.[7]

THE RATIONALE OF THE LPP-1'S INTERVENTION MODEL

The assessment of the rationale of the intervention model is particularly relevant to the evaluation of a pilot project such as the LPP, which explicitly aimed at testing innovative strategies of funding and providing agricultural extension services. In particular, the LPP aimed at verifying

[6] Source: "Project Completion Report (PCR)" corresponding to the loan OC-UR/1299 presented to the Inter-American Development Bank, April 2004.

[7] 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.

the feasibility of a model where the private sector was supposed to take the leadership of both the demand and supply side of the technology adoption process, while the role of the public sector was limited to oversight and co-financing functions.

To investigate the rationale of this approach, we referred to the literature that analyzes the role of private and public actors in the technology uptake of rural producers. This literature, which originated from the analysis of public extension agencies, has significantly evolved overtime, producing wider and more complex definition of extension services.[8]

The justification for public support to the technological uptake of rural producers traditionally lied on the public-good nature of the knowledge to be transferred. Instructions on how to use productive resources, or information on the benefit of new productive technologies were generally classified as public goods, since they are non-rival, non-excludable and, therefore, their benefits are difficult to appropriate. However, as any other good, knowledge is not public in essence (Coase 1974). The knowledge transmitted by extension could be embodied in an excludable good, such as a machine or a productive input (Hanson and Just, 2001), or it could be tailored to specific needs of specific farmers. In these cases, knowledge is excludable and the extension services could be marketed as a private good (Anderson and Feder, 2004, Dinar, 1996).

This discussion clearly implies that the characteristics of the transferred knowledge affect the best way of funding and providing extension services. Anderson and Feder (2004), for instance, point out that the diffusion of information associated with market goods should be generally left to the private initiative, while the one related to toll goods, with high excludability but low rivalry, to a combination of public and private provision. They also remark that information on common pool goods, i.e. goods with high rivalry and low excludability, could be better managed by cooperatives or NGOs. Finally, they recommend public financing of

[8] Overtime, extension services have become "a system and the set of functions performed by that system to induce voluntary change among rural people" (Feder et al., 1999:3).This system includes public, private and semi-public agents that fund and provide services related different functions (Zijp, 1998). These functions include the transfer of technology, the transfer of managerial practices, and the transfer of knowledge and capacities (Birkhaeuser et al., 1991, Evenson, 2001 and Owens et al., 2001).

extension services only in the case of non-rival, non-excludable information.

The characteristics of the potential beneficiaries, and of the markets they have access to, also play a significant role in determining the best way to finance and to provide extension services. The producers that are willing to pay for extensions services are usually those that: (i) have the capacity to pay for them; (ii) have access to information about the available techniques and the ability to calculate their potential benefits; (iii) have the skills to absorb new technologies and practices; (iv) have access to a market of extension services with agents that can respond to their demands.

The capacity-to-pay or affordability argument becomes highly relevant under imperfect markets with credit constraints. Low-income farms, especially those with no land titles, may not be able to purchase extension services even when the private returns are higher than costs. Asymmetric information between lenders and farmers and the uncertainty in agricultural production could, in fact, lead to imperfect credit markets.[9]

The lack of access to information and the inability evaluate the benefit of innovations have always been one of the major justifications for the public provision of extension services.[10] Asymmetric knowledge on the value of the service itself implies that benefits are difficult to appropriate through market prices, even when the service regard rival and excludable goods. In many cases, the demand for knowledge by poorer and less educated farmers tends to be lower also because of their inability to recognize its potential benefits. In this sense, Alex and Rivera (2005) conclude that the transition to privatized extension cannot be successful without contingency programs for human capacity development. Remoteness and

[9] However, these market failures do not necessary imply direct public provision. Sunding and Ziberman (2001) argue that the provision of subsidized credit at the beginning of the diffusion process can change the perception of lenders and diminish the problem of credit constraints. Duflo et al. (2004) find that farmers could behave as hyperbolic discounters and that a commitment device to make them purchase the services when they have the liquidity could be more effective that than subsidized credit.

[10] The original objective of US Cooperative Extension in 1914 was to diffuse information on new technologies, under the assumption of asymmetric information between farmers and extension agents (Hanson and Just, 2001).

sparseness of producers could be an additional source of relevant asymmetries between agents and producers.

The absorptive capacity of the producers significantly affect the inclination to use and pay for extension services. Assuming learning as a cumulative process (Cohen and Levinthal, 1990 and Rosenberg, 1990), the assimilation of new knowledge is easier and lees expensive for the producers with a larger initial knowledge endowment. In addition, more knowledge in a specific field allows to better identity and exploit new technological opportunities. Therefore, the more educated and skilled the producers, the lower are the cost of adopting technologies and practices and the higher the potential benefits (Umali and Schwartz 1994).

Private suppliers of extension services usually emerge spontaneously with the development of agricultural markets, when the same services are not freely provided by the public system (Chapman and Tripp, 2003). These services usually concern knowledge with sufficient rivalry, excludability, and appropriability conditions. Services related to contract farming, the purchase of inputs, and veterinary assistance are frequently provided by private agents. Agro-processing and marketing firms offer extension advice under contract farming[11]. Technical, credit and commercial assistance could be also delivered by tractor companies, seed producers, or even dealers of pharmaceutical products. Once again, remoteness and sparseness of producers can significantly hamper the formation of private extension markets, because the providers should be able to realize significant economies of scope by offering a broad rage of services to profitably reach remote areas.

These considerations led several governments to deeply reform the traditional approach to the extension services. Alex and Rivera (2005) point out that these reforms included decentralization, privatization, demand-driven approaches and the adoption of innovative designs for public policies. To account for these innovations, Hanson and Just (2001) identify five categories of extension services: (i) public extension, with public funding and delivery in the traditional way, (ii) paid public extension, with public provision, but a fee-for-service funding, (iii) partially public-funded private extension, delivered by private firms and

[11] Umali and Schwartz (1994) provide evidence of the existence of this kind of service around the world.

financed in part by public budgets and in part by user fees, (iv) policy-supported private extension, provided by firms and financed by users, but with government subsidies or taxes for specific production techniques, and (v) private extension, provided by private firms that charges fees for their services.[12]

The LPP project clearly fall into the categories policy-supported private extension. In particular, the LPP is based on a setting that aims at combining public and private interests to promote the adoption of new technologies and managerial best practices. Ex-ante, the LPP defined only a wide range of expenses eligible for co-financing. The producers, with the support of the facilitators, were responsible for identifying the technology and practices they were willing to pay for, and they were forced to plan the implementation and to quantify the benefit of the adoption process. Ex-post, the LPP executing agency, again with the support of the facilitators, had the authority to approve or reject the investments plans prepared by the producers.

This process of private identification and public selection of the projects to be co-financed with public resources should have allowed promoting the adoption of technologies and practices with a certain level of excludability and rivalry, but, at the same time, with a significant social return. In addition, the fact that a facilitator were asked to manage between 10 and 100 business plans aimed at fostering the creation of clusters or networks of producers and technicians, which should have allowed the diffusion of best management practices as well as the generation of opportunities to foster the associations between small-scale producers.

Therefore, the justification of the public financial support provided by LPP-1 includes both motivations related to the nature of the innovations and motivations related to the characteristics of the potential beneficiaries. With regard to the nature of the innovations, the LPP-1 assumed that the innovations needed by the Uruguayan producers were appropriable only in

[12] There is a sort of consensus in the literature on the necessity of a stratified, pluralistic system (Feder et al., 1999, Anderson et al., 2006, Alex et al., 2004, Alex and Rivera, 2005). The stratification of services could imply that public extension should focus in small-scale, non-commercial poor farmers, while the fee for service extension is left for commercial farmers. Anderson et al. (2006) recommend a system in which private providers coexist with NGOs and producer organizations.

the short run.[13] The LPP-1, in fact, assumed that once the changes adopted by the beneficiaries had proved their benefits, they would have rapidly adopted by non-beneficiary producers as well. With regard to the characteristics of the producers, the LPP-1 assumed that these potential first movers had the human and financial resources needed for undertaking managerial and productive changes, but not enough market incentives to do it. Therefore, a limited public financial support, aimed at reducing the cost of being a first mover, should have provided the right incentives for activating a process of technological uptake.

The intended targeted beneficiaries of the LPP-1 seem to correspond to the requirements of a policy-supported private extension intervention model. According to design and supervision documents and to a series of interviews with various stakeholders (beneficiaries, facilitators and public officers), the LPP-1 clearly intended to target relatively well educated producers, capable of formalizing an innovation idea into a business plan, capable of implementing a technology adoption process and endowed with the financial resources needed to co-finance the process.

However, this targeting strategy clearly exposed the matching-grant mechanism to the risk of attracting rent-seekers. Without proper supervision instruments, targeting producers that have both the skills and the financial resources to implement the innovation projects even on their own could clearly have incurred into the risk of financing projects that would have been undertaken in any case. The simple analytical framework presented in Annex 1 shows that the LPP-1 matching grant was most likely to be effective when granted to producers that would not have invested in extension services in the absence of the subsidy, or that planned to invest, but were limited by financial constraints. However, the

[13] In addition, the LPP implicitly assumed that the price dynamic in the meat industry would have allowed the breeders to appropriate of the economic benefit of their increased productivity, at least in the medium run. On this point, the LPP design was much less convincing, since it repeatedly pointed out the unbalanced structure of the different stage of the livestock production chain, where the breeding stage was by far the more competitive. In any case, the assessment of the effect of industry structure on the LPP effectiveness goes beyond the scope of this paper.

highly illiquid temporary structure of the LPP-1's disbursements would probably have discouraged the latter producers form participating.[14]

From the previous discussion, it is clear that the selection and supervision of the beneficiaries, both activities under the responsibility of the facilitators, played a crucial role in determining the effectiveness of the LPP-1. A detailed review of the LPP-1 operational design shows that the facilitators were exposed to both perverse incentives and conflict of interests. Both these problems come from the fact that the earnings of the facilitators, who were responsible for indentifying, pre-selecting and supervising the beneficiaries, were conditional upon the results attained by the beneficiaries. In terms of perverse incentives, this compensation mechanism could have induced the facilitators to target producers that had a high probability of accomplishing the planned goals, and innovation projects that required a low level of supervision and mentoring, i.e. projects involving already validated and consolidated techniques and practices.[15] In terms of conflict of interests, this compensation mechanism could have induced the facilitators to loosen up the verification of both the baseline condition and final achievements and to simply accept the information provided by the beneficiaries. It is quite clear how these problems could have exposed the program to a high risk of financing rent-seekers, if the facilitators were not adequately audited by the executing unit.[16]

[14] The subsidy, in fact, was paid only after demonstrating the attainment of objectives, which imply that the producer needed to be not financially constrained for the full amount of the project they proposed. Also, disbursements were pro-cyclical, in the sense that grew proportionally to the accomplishment of the targets, which is clearly affected by macroeconomic or sectorial conditions. Additionally, for the producer point of view, 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.

[15] The probability that a small-scale producer approaches a facilitator was clearly 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.

[16] The only measure adopted by the LPP executing unit to mitigate this conflict of interest was the introduction of a system of independent auditing aimed at verifying the veracity of the information provided by facilitators. Considering a sample of 12% of business

RESEARCH HYPOTHESIS, METHODOLOGY AND DATA

Research Hypothesis: the expected impacts of the LPP-1

First and foremost, this evaluation aimed at indentifying the average impact of the LPP on the intended development outcomes as they were defined in the original design of the project. In particular, the LLP design indentified two specific outcomes indicators for component 1: (i) the Reproductive Efficiency Index (REI): the LPP-1 was expected to produce a significant improvement in the productivity of the breeding activities; (ii) the rate adoption of managerial practices: the LPP-1 was expected to induce significant improvement in the practices the beneficiaries used to manage their production and to administer their activities.

In addition to the average impact of the LPP-1 on these indicators, we were also interested in assessing the distribution of impacts across beneficiaries with different productive orientations. In fact, although LPP-1 was originally intended to target small-medium breeders, it ended up targeting producers that operated in the breeding stage at different level of intensity. With this analysis of the heterogeneity of impact, we aimed at assessing the quality of the targeting of the LPP-1.

After evaluating the impact on its specific outcome indicator, we also considered the impact of the LPP-1 on the relative specialization of the beneficiary producers, with particular attention to the specialization towards the breeding activities. In fact, the increase of the rate of specialization of the breeders was one of the general expected outcomes of the LPP, to which the Component 1 was expected to significantly contribute.

A final question that needed to be addressed was whether the effectiveness of the LPP-1 varied according to the amount of subsidy received. One of the basic assumptions of the LPP-1 was that a limited financial support would have generated the right incentive to induce the producers to undertake innovative changes. The limits of this financial contribution were defined both in terms of co-financing percentage and in terms of maximum amount. In this sense, the identification of a "dosage effect"

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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).

would have provided relevant insights for the expansion of the LPP on a larger scale.[17]

Methodology and Data

An impact evaluation seeks to estimate the changes in the outcome indicators that are attributable to the public policy, while controlling for the effect of other factors that may simultaneously influence these indicators. This control becomes relevant in the case of the LPP as much as for the volatility of the macroeconomic environment and of the livestock sector in Uruguay during the LPP execution, as for the differences between the characteristics of the beneficiaries and non-beneficiaries.

The measurement of the impact of the LPP poses the so-called "evaluation problem". Define Y^1_i the outcome indicator of the producer i between if the producer participated in the LPP, and Y^0_i the outcome indicator of the same producer if the producer did not participate in the LPP. Measuring the program impact requires a measurement of the difference $Y^1_i - Y^0_i$, which is the effect of having participated in the program for producer i. Computing $Y^1_i - Y^0_i$ requires knowledge of the counterfactual outcome Y^0_i, which is not empirically observable since a producer cannot be observed simultaneously as a participant and as a non-participant. However, although we cannot compute the program impact for an individual producer, we can still evaluate an average effect of participation in the LPP, $E[Y^1 - Y^0]$ by comparing data on participating and non-participating producers.

Defining D as the dummy variable takes the value of 1 for those producers that were beneficiaries of the LPP and 0 otherwise the impact of the project can be defined as:

$$\Delta = E[Y^1, D=1] - E[Y^0, D=0] \qquad (1)$$

Subtracting and adding $E[Y^0 \mid D=1]$, we obtain:

[17] At the time of this evaluation, the scale-up of the LPP was already approved. One of the modifications introduced in the new project was the reduction of the maximum amount of the subsidy to US$ 4,000. For this reason, we also used this specific amount as cut-off point for the dosage analysis.

$$\Delta = E[Y^1 \mid D=1] - E[Y^0 \mid D=0] - E[Y^0 \mid D=1] + E[Y^0 \mid D=1]$$
$$= E[Y^1 - Y^0 \mid D=1] - E[Y^0 \mid D=0] + E[Y^0 \mid D=1] \quad (2)$$

The term $E[Y^1 - Y^0 \mid D=1]$ in (2) is the average effect of the treatment on the treated that we try to isolate. The difference $E[Y^0 \mid D=1] - E[Y^0 \mid D=0]$ is the selection bias: besides the effect of the program there may be systematic differences between participating and non-participating producers that affect the variation of the outcome indicator.

A simple estimator of Δ using the sample analogue $E[Y^1 \mid D=1] - E[Y^0 \mid D=0]$ will give an unbiased estimate of the program impact only if there is no selection bias, that is only if $E[Y^0 \mid D=1] = E[Y^0 \mid D=0]$. However, participating and non-participating producers differ in a number of dimensions (e.g. size) that are likely to affect both the outcomes indicator and the probability of participating in the LPP. Therefore, the simple difference in mean outcomes between participants and non-participants is capturing the effect of program participation together with the impact of third factors affecting both the outcome indicator and to the participation in the program.

For the evaluation of the LPP impact, we followed a standard quasi-experimental approach and we computed an Average Treatment Effect on the Treated (ATT) through the Difference-in-Difference (DID) with Propensity Score Matching (PSM) technique.

In practice, a simple DID estimator would compute equation (1) using the variation of the outcome between before (t) and after (t') the LPP:

$$\Delta^{DID} = [Y^1_{t'} - Y^1_t \mid D=1] - [Y^0_{t'} - Y^0_t \mid D=0] \quad (3)$$

where the identifying assumption becomes:

$$E[Y^0_{t'} - Y^0_t \mid D=1] = E[Y^0_{t'} - Y^0_t \mid D=0] \quad (4)$$

Therefore, the validity of a simple DID estimator relies on the assumption of time invariant linear selection so that differencing the difference

between beneficiaries and non-beneficiaries eliminates the selection bias (Heckman et al. 1998). This means that the validity of the DID estimator rests on the assumption that the decision to participate into the program depends on producers' characteristics that remain constant over time.

There are three potential source of bias that a simple DID estimator cannot control for: (i) temporary individual-specific effects that could drive the participation into the program; (ii) the potential correlation between modifications in the treatment and the outcome variable; (iii) differential impact of common exogenous effects on beneficiaries and non-beneficiaries.

To completely rule out the first potential source of bias, one should test that the outcome variables experienced a common trend for beneficiaries and non-beneficiaries prior to the LPP. Unfortunately, the lack of data did not allow this test. In the case of the LPP, it is reasonable to assume that only an exceptionally good temporary ex-ante performance might have affected the decision of participating, given the significant financial and operative efforts required to the beneficiaries. If this occurred, a simple DID could underestimate the LPP's results. However, the rather complex modality of application and the ex-ante uncertainty of the program net-benefit, should have significantly limited the role of temporary effects on the decision to participate in the LPP. Therefore, this particular bias, if occurred, is likely to be at worst very small, and at best negligible. The second potential source of bias did not play any role. In fact, during the period of time under consideration the LPP did not experience any significant change. The last potential problem could have been more relevant. In fact, Uruguay was experiencing a major macroeconomic problem during the period under consideration. Differences between beneficiaries and non beneficiaries could have determined different reactions to the macroeconomic shocks, generating a bias in the simple DID estimation.

To mitigate these problems, we adopted the standard strategy of combining DID estimator with Propensity Score Matching (PSM). The main advantage of using a "conditional DID estimator" is that it allows to correct for selection biases on both observable (matching) as well as time-invariant unobservable (DID). In our case, we were mainly interested in calculating our DID estimator on a sample of beneficiaries and non-

beneficiaries similar enough to reduce the likelihood of the biases (i) and (iii) previously discussed.

The PSM consists in estimating the following non parametric model:

$$\Delta_{PSM}^{DID} = E[E(Y^1_{t'} - Y^1_t \mid D = 1, p(x)) - E(Y^0_{t'} - Y^0_t \mid D = 0, p(x)) \mid D = 1] \quad (5)$$

where $p(x) \equiv P(D = 1 \mid X) = E(D \mid x)$ is the propensity score, that is the conditional probability to participate in the LPP calculated on a set of covariates that are likely to affect both the variation in the outcome indicator and the probability of participating in the LPP.

This method consists in determining a probabilistic 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 computed for each producer. 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) 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.[18] 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 treatment effect is obtained. In the literature, different methods are suggested to construct the control group (for a survey see Becker and Ichino, 2002). 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. In order to verify this capability, t-statistics are performed on the characteristics of beneficiaries and the control group.

[18] For a complete methodological revision of this approach see Blundell and Costa Dias (2002). For elaborations on the methodology see Heckman et al. (1998), Deherejia and Wahba (1999), Abadie et al. (2004).

We conducted our estimation on 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 collected in order to obtain a representative sample at national level, according to agricultural census raised in 2000. The dataset includes the characteristics of the producer, administrative management indicators, technical assistance indicators, and indicators for implementation and technology. To maintain a balanced panel, we restricted the panel to those producers for whom data were available for both periods. The data for the group of beneficiaries was obtained from the PCU's information system. The data for non-beneficiaries was obtained from the livestock surveys collected in 2001 and 2003 by the DIEA.

EMPIRICAL RESULTS

Participation Model

As we argued in section 3, the preferences of the facilitators in selecting the beneficiaries could have determined significant differences between the characteristics of producers in the treated sample and those in the non-treated sample. This aspect is of no small significance, since it introduces potential biases at the time of determining what part of the improvement in the outcome indicators is attributable to the participation in the LPP-1. This potential selection bias justifies the use of estimation techniques that aim at indentifying an appropriate counterfactual scenario.

When we compared the characteristics of the beneficiaries with those of the control group, as expected, we found significant differences in terms of farm size, location, education, and adoption of technical and managerial practices. Indeed, table 1 shows that the sample of beneficiaries is characterized by having an average farm size 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, the data show that the average age of beneficiaries is 47 years old versus 54 years for the control group. Forty-six percent (46%) of the beneficiaries could be defined as fully specialized in breeding activities, while only 39% of the

controls fall in the same category.[19] 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. Forty-three percent (43%) of the beneficiaries have some form of work outside the farm, in contrast to 27% in the control group. In the area of technical assistance, the data show 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. Twenty-six 26% of beneficiaries implemented cattle check-ups and 65% implemented some form of pregnancy diagnosis, compared with 62% and 53% for the control group, respectively. Finally, 70% of beneficiaries had registries of physical events and 78% of registries for economic activities, compared with 69% and 74% for the control group.

[19] To categorize producer beneficiaries in terms of their productive orientation we used a three category classification commonly used in livestock studies in Uruguay (see DIEA, 2002): cattle breeding, complete cycle or wintering. According to this classification the specialization of a producer is determined on the basis of the ratio between the numbers of steers older than two years divided by the number of breeding cows. If the ratio is less than 0.2 the farm is classified as oriented towards breeding, if the ratio is between 0.2 and 2 the farm is classified as complete cycle, and if the ratio is superior to two, the farm is classified as oriented to wintering.

Table 1
Descriptive Statistics for Beneficiaries vs. Non-beneficiaries

	Beneficiaries		Non Beneficiaries	
	Mean	**SD**	**Mean**	**SD**
Land Size *(1000 has)*	**0.92**	0.62	**2.62**	2.67
Montevideo=1	**0.13**	0.34	**0.04**	0.19
CONEAT Index	**91.2**	26.1	**91.7**	27.9
Age of the Farmer (Years)	**47.2**	10.8	**53.7**	14.8
Undergraduate or Technical Studies=1	**0.05**	0.21	**0.02**	0.13
Farmer was involved in Activities Outside the Farm=1	**0.43**	0.50	**0.27**	0.44
Received Technical Assistance from a Private Agronomist=1	**0.73**	0.45	**0.91**	0.29
Received Technical Assistance from a Private Veterinary=1	**0.91**	0.28	**0.95**	0.22
Participated in another MGAP program=1	**0.23**	0.42	**0.06**	0.24
Reviewed the bulls=1	**0.26**	0.44	**0.62**	0.49
Diagnosis of Pregnancy=1	**0.65**	0.48	**0.53**	0.50
Productive Orientation (Breeders=1)	**0.49**	0.50	**0.36**	0.48
Keep Register of Physical Events=1 *(2001)*	**0.70**	0.46	**0.69**	0.46
Keep Register of Physical Events=1 *(2003)*	**0.96**	0.18	**0.71**	0.45
Keep Register of Physical Events=1 *(Change 2003-2001, %)*	**26.05**	46.60	**1.49**	48.63
Keep Register of Economic Events=1 *(2001)*	**0.78**	0.41	**0.74**	0.44
Keep Register of Economic Events=1 *(2003)*	**0.92**	0.27	**0.82**	0.38
Keep Register of Economic Events=1 *(Change 2003-2001,%)*	**13.71**	41.36	**7.66**	42.13
WP *(2001)*	**67.02**	8.61	**65.53**	15.95
WP *(2003)*	**71.07**	9.81	**71.31**	14.55
WP *(Change 2003-2001, %)*	**3.87**	11.25	**5.41**	19.62
REI *(2001)*	**50.32**	10.34	**40.10**	14.97
REI *(2003)*	**55.10**	11.55	**43.96**	14.51
REI *(Change 2003-2001, %)*	**4.79**	13.97	**3.65**	17.87

Source: Authors' elaboration on data from DIEA and MGAP.

In order to evaluate the relative relevance of these characteristics in determining the selection bias, we estimated a discrete logit model where the dichotomous depended variable is the participation in the LPP. Table A1 in annex 2 presents the results of the model's estimations. As a general

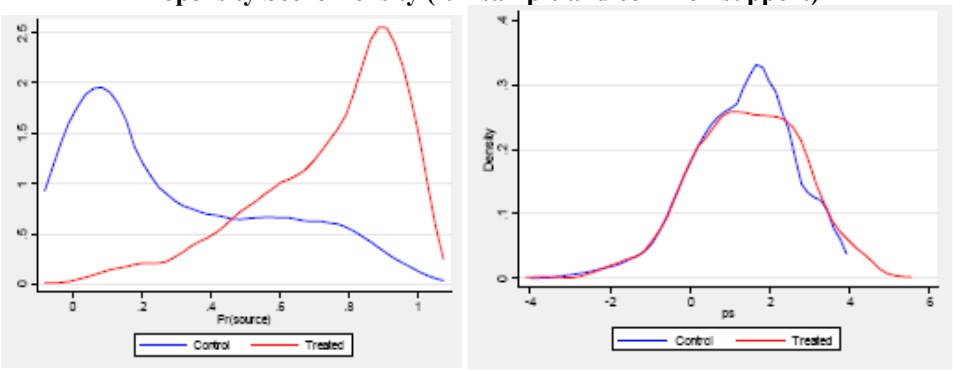
pattern, we found that the group of beneficiaries and the control group show statistical similarities in the CONEAT index, percentage of technical assistance from private veterinaries or agronomists, percentage of breeders that keep registries of physical events and the weaning percentage after controlling for other characteristics. Moreover, we found that the beneficiaries are characterized for being older, although at decreasing rates, having higher levels of education, more likely living in Montevideo, having some activity outside the farm, having participated in some of the MGAP's programs before 2001, keeping a registry of economic events and implementing pregnancy diagnosis. Conversely, non-beneficiaries are characterized for having farms of greater size and not implementing livestock check-ups.[20]

As table A1 shows, the goodness-of-fit of the estimated participation models is relatively high compared to the outcomes of the participation model commonly used in impact evolutions, with a pseudo-R2 that fluctuates between 39% and 52%. The values of the coefficients and their significance vary in the different specifications, but they always maintain consistent sings and magnitudes. Indeed, after eliminating the variables that are not significant, the values of the remaining parameters and the goodness of fit indicator do not experience major modifications.

On the basis of this participation model, we then computed the distribution of the propensity score for each producer included in the treated and control groups to identify the existence of a common support. Graph 1 shows that there is wide area in which the propensity score of beneficiaries is similar to those of non-beneficiaries.

[20] 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.

Graph 1
Propensity Score Density (full sample and common support)



Note: to calculate the propensity score reported in this graph, we used model 4 reported in Annex.

We tested different methods to calculate the propensity scores and to carry out the matching. In particular, we used alternative propensity scores, including various explicative variables, such as squared variables, and interactions terms between the covariates of the participation model. In the same manner, we constructed the control groups 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, we opted to work with the propensity score obtained with model M4 presented in table A1 annex 2, and to use the kernel-Epanechnikov for the matching. This choice allowed us to reconcile the need to balance the characteristics between beneficiaries and the control group with the need to obtain an acceptable number of observations.

In order to verify the quality of the matching, we tested it of by comparing the difference in means of the covariates with and without restricting the sample to the propensity score common support. The balance table reported in annex 2 (table A2) show that the PSM significantly reduces the biases in most of the observable characteristics that differentiate beneficiaries from non-beneficiaries.

Impact Evaluation Results: Management and Productivity Indicators

To evaluate the impact of the LPP-1 on managerial practice indicators, we focused on the percentage of producers that adopted physical and economic registries. In addition to be the indicators indentified by the original design of the LPP, the adoption of this simple practices is considered a fundamental step in the development of a livestock activity, because it allows the producers to monitor the productive and economic performance of their farms and to make informed decisions.

To evaluate the impact of the LPP-1 on productivity, we focused on two typical productivity indicators of the breeding activities: (i) the percentage of weaning (WP) and (ii) the Reproductive Efficiency Index (REI). Although the structure of these indicators is still partially debated, they are usually defined as follow:

$$\text{WP} = \frac{Calves}{Breeding\ Cows} \tag{6}$$

$$\text{REI} = \frac{Calves}{Cows\ more\ than\ one\ year\ old} \tag{7}$$

The WP and the REI are average production indicators that measure the ability 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 considered capable of producing calves. On one hand, the weaning percentage considers exclusively breeding cows. On the other hand, the REI also consider 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. There is a certain consensus in the literature that the REI is a better indicator than the weaning percentage in determining reproductive efficiency.[21]

By simply comparing the evolution overtime of the indicators, we found that the beneficiaries of the LPP-1 outperformed the control group in all the considered indicators, but the WP. This first approximation of the LPP-1 impact simply considers the difference of the evolution of the indicators between beneficiaries and non-beneficiaries, that is, a

[21] On this topic, see Rovira (1996), Adler y Murguía (2000), Caputi y Murguía (2003).

difference-in-difference estimator. In particular, the data show that the number of beneficiaries that keep registries of economic events increased by 13.1 percentage points during the implementation of the project, while for the group of non-beneficiaries it increased by 7.7 percentage points. As for the registries for physical events, the 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 3.9 percentage points versus 4.5 percentage points for the control group. Finally, the REI increased by 4.9 percentage points for beneficiaries and 3.2 for non-beneficiaries.[22]

However, when we restrict the two samples to the propensity score common support, we found a positive and significant impact of the LPP-1 only on the adoption of managerial practices. In particular, table A3 in the annex shows that the LPP-1 significantly contributed to increase the number of producers who keep registries for physical and economic events, by respectively 25 and 18 percentage points. However, although the data show that both beneficiaries and non-beneficiaries increased their productivity, we could not attribute any significant effect to the LPP-1 in terms of WP and REI.

In addition to the general average impacts of the LPP-1, we were also interested in estimating the distribution of these impacts among beneficiaries grouped by their initial productive orientation. We first restricted the analysis to those producers with an initial productive orientation for breeding or for complete cycle, excluding those mainly dedicated to wintering.[23] The results of this estimation confirm that the LPP-1 contributed to the increase in the percentage of producers that keep registries for physical and economic events, but they still do not show any significant impact on productivity indicators, consistently with the results computed on the complete sample.

[22] 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 REI. Source: PCR

[23] As previously discussed the LPP-1 was supposed to target producers that were already undertaking some breeding activities. This also explains why the LPP design originally identifies productivity indicators typical of the breeding stage.

We then further restricted the analysis to the producers initially specialized in cattle breading. Although the limited number of observations in the common support suggest to be very cautions when interpreting the results we found some evidence of a positive and significant impact of the program on one productivity indicator. The results reported in table A4 in annex 2 suggest that for these set of producers the LPP-1 not only contributed to increase the percentage of producers who keep economic registries by 22 percentage points, but also generated an impact of 6.7 percentage point on the REI of the beneficiaries. To complete the analysis, we also considered the sub-group of producers who had a complete cycle orientation (table A5), we found that the project impact is limited to a 15.8 percentage increase in the number of producers who keep registries of physical events.

Although the data limitation did not allow generalizing these results to all the participant breeders, we were interested in calculating the economic value of such positive efficiency increase detected by our analysis, to provide a rough estimation of the potential return of the public subsidy. For this purpose, we considered 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*370*US$210=US$5,183 during 2001 and 2003. However, if the increase in the REI 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 that a steer weighs 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 that 200 kg of carcass (54% of output) can be obtained from the 432kg, we estimated 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 our analysis, we also considered the impact of the LPP-1 on the relative specialization of the beneficiary producers. The lack of specialization, especially at the breeding stage, was indeed one of the major concerns of the Uruguayan authorities when the LPP was designed, and the LPP-1 was supposed to positively contribute to an increase in the specialization degree of the producers, in particular of the breeders. [24]

Table 2
Transition Matrix of the Productive Orientation (number of producers)

Whole Sample

		2003		
		Breeders	**Complete Cycle**	**Total**
2001	**Breeders**	147	125	272
	Complete Cycle	126	219	345
	Total	273	344	617

Beneficiaries

		2003		
		Breeders	**Complete Cycle**	**Total**
2001	**Breeders**	81	104	185
	Complete Cycle	100	92	192
	Total	181	196	377

Non Beneficiaries

		2003		
		Breeders	**Complete Cycle**	**Total**
2001	**Breeders**	66	21	87
	Complete Cycle	26	127	153
	Total	92	148	240

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

[24] IDB (2001), paragraph 1.4.

During the execution of the LPP, both the beneficiaries and non-beneficiaries producers experienced a high mobility in terms of productive orientation. Table 2 shows the mobility of the productive orientation for our sample of 617 livestock producers. From a first reading of the aggregate results in table 2, one would conclude that between 2001 and 2003 the proportions of produces with orientation towards cattle breeding and complete cycle remained almost stable at 44% and 56% respectively. However, the aggregate data hide the real dynamic experienced by the producers. In fact, considering the disaggregate figures reported in central column of table 2, only 44% of producers initially oriented to breeding and 63% of producers initially oriented to complete cycle, maintained their productive orientation between 2001 and 2003. This high mobility also emerges when we analyze beneficiaries and non-beneficiaries separately, even though the beneficiaries show a slightly more active dynamic.

In order to determine the impact of the LPP on the producer specialization, we constructed a series of specialization indexes (SPI):

$$SPI_1 = 100 \cdot \frac{|1.1 - r|}{1.1} \tag{8}$$

$$SPI_2 = \frac{[100 * (1.1 - r)]^2}{121} \tag{9}$$

$$\text{where } r = Min\left\{ \frac{Steers\ older\ that\ 2\ years}{Breeding\ Cows}, 2.2 \right\}$$

Both SPI_1 and SPI_2 increases as r gets further away from 1.1=0.5*(0.2+2), which means that the producer moves away form the complete cycle orientation toward either the specialization in breeding or wintering. SPI_1 does it at a constant rate and SPI_2 does it at an increasing rate (see graph A1 in the annex).

Evaluating the impact of LPP-1 on these two indicators, we found that although both beneficiaries and non-beneficiaries increased their specialization, the increase experienced by the non-beneficiaries significantly exceeded that of the beneficiaries (table A6 in annex 2).

However, since the LPP-1 specifically aimed at promoting the efficiency of breeding activities, we isolated the effect that the project could have on inducing those producers with an initial complete cycle or breeding orientation to further specialize in breeding activities. In a complementary manner, we also isolated the opposite effect, that is the potential reduction of specialization in breeding activities of those producers with an initial complete cycle or breeding orientation. For these purpose, we used a both linear and a non-linear indicators to measure the increase (SPI_3 and SPI_4) decrease (SPI_5 and SPI_6) in breeding specialization (see graph A1 in the annex):

$$SPI_3 = 100 - 50r, \; r \in [0.2,2] \tag{10}$$

$$SPI_4 = 100 - 100r + 25r^2, \; r \in [0.2,2] \tag{11}$$

$$SPI_5 = 50r, \; r \in [0.2,2] \tag{12}$$

$$SPI_6 = 25r^2, \; r \in [0.2,2] \tag{13}$$

The results reported in table A7 and A8 in annex 2 show that the LPP-1 positively contributed to fostering the specialization of this subgroup of producers: in fact, when we restrict the sample to those producers with an initial complete cycle or breeding orientation, the number of beneficiaries that increased their specialization in breeding activities is higher than the number of non-beneficiaries, while there is no significant difference in the number of those that reduced their specialization.

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

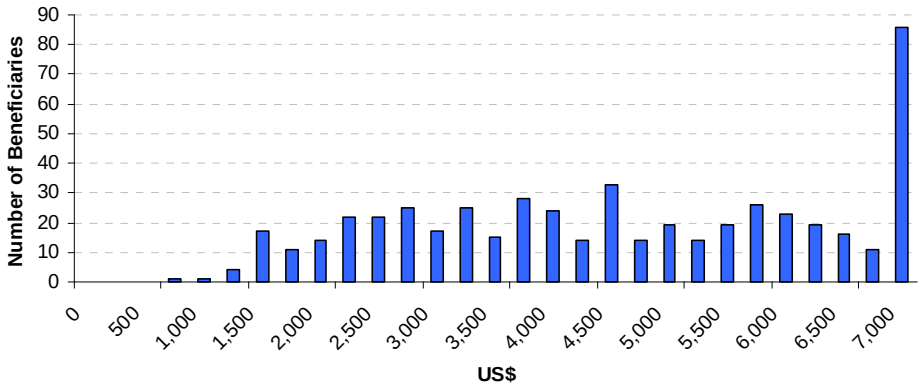
This section aims at identifying if the effects of the LPP-1 on productivity indicators depended on the amount of the subsidy received by the beneficiary producers, what is usually defined as dosage effect. Graph 2 shows that the distribution of the solicited subsidies is rather concentrated on the maximum amount allowed by the LPP-1, i.e. US$ 7.000.

[25] It is important to note that the parameters for the quadratic function were selected arbitrarily with the purpose of obtaining an indicator non-linear and decreasing at growing rates in *r* for the range of values of *r* in which the indicator is defined.

[26] Indicators 4 and 6 have a slope of zero when the indicator is zero and a slope of 100 when the indicator is 100.

Adopting first a simple parametric approach, we found that the amount of the subsidy is a positive and significant determinant of the REI of the producers (see table A8 in the annex). We obtained these results by estimating two parametric models where the dependent variables were the variation of the two productivity indicators, the REI and WP, and the independent variables were the amount of subsidy, the characteristics of the farms and the characteristics of the producers. We found that the subsidy had a positive and significant effect on the REI, when we considered the complete sample of beneficiaries and non-beneficiaries. However, when we restricted the sample only to the beneficiaries, the parameter associated with the subsidy turned out to be not significant. In the case of WP, we did not found any significant effect with both the whole and the restricted samples.

Graph 2
Distribution of the Solicited Subsidies



In order to identify any potential threshold effect of the subsidy amount, we also implemented a non-parametric approach following the methodology developed by Imbens (2000). This methodology consists in an extension of the Propensity Score Matching and requires separating the beneficiaries into different groups according to the dosage of treatment they received, in this case the amount of the subsidy. For this purpose, we implemented a cluster analysis with the K-means method to separate beneficiaries into *k* groups indentified on the basis of the subsidy amount, considering k = 2, 3, and 4. Table A9 in the annex presents some statistics on the subsidies received by groups of recipients. Subsequently, we

estimated four participation models using a logit model for k=2 and, an ordinal logit for k=3 and 4 (see table A9 in annex 2).[27] Finally, we estimated the impact associated with soliciting higher levels of subsidy, considering k=2, 3, and 4. In each case, we used the group that solicited a smaller subsidy as the control group, while the groups with higher subsidies were used as the treatment group.

The results of this approach, which are reported in table A10 in annex 2, suggest that there were no increasing effects associated with higher levels of subsidies granted by the LPP-1. Since we found consistent non significant results in all the specifications of the cluster analysis, we concluded that the LPP-1 did not produce any significant dosage effect. [28]

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 Surveys (DIEA 2002, 2004) and from the Project Coordination Unit (PCU) to set up a unique panel dataset of 990 observations, 520 for beneficiaries and 470 for non-beneficiaries. Descriptive statistics show that the characteristics associated with the beneficiaries and non-beneficiaries present significant differences. This justified the implementation of econometric methods aimed at identifying a proper counterfactual scenario.

For this purpose, we estimated the impacts of the LPP 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.

[27] These models were estimated on all the variables included in the participation model presented in the previous section. In an effort to maintain a sufficient number of observations, some non-significant covariates were progressively eliminated, without significantly reducing the goodness-of-fit of the model.

[28] We also estimated the dosage effect using a discretionary cut-off point of two groups of recipients at US$4,000. As previously mentioned, this cut-off point was of particular interest, because the scale up of the LPP-1 lowered the maximum amount of the subsidy to US$4,000. However, we did not found any found any differentiated effects on the productivity indicators and of administrative management indicators for the beneficiaries that received subsidy above or below this specific cut-off.

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. As a general pattern, we found that beneficiaries are characterized for being older, although at decreasing rates, having higher levels of education, more likely living in Montevideo, having some activity outside the farm, having participated in some of the MGAP's programs before 2001, keeping a registry of economic events and implementing pregnancy diagnosis. Conversely, non-beneficiaries are characterized for having farms of greater size and not implementing livestock check-ups. Testing after the matching, we found that the selected and treated groups were balanced in most relevant covariates.

The results of the impact evaluation show that the LPP-1 positively affected the rate of adoption of managerial practices, such as keeping record of physical and economic events. Our results also show some evidence that the project could have 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 that experienced such increase.

We also found evidence of a high mobility in the productive orientation of producers during 2001 and 2003, and that the LPP-1 effectively promoted specialization in breeding activities only when properly targeted. In fact, the results indicate that, for the complete sample, the project did not have influence on the changes of productive orientation. However, we found that for the sub-group of producers that had a significant level of initial breeding activities, the LPP-1 effectively promoted specialization.

Finally, we found that there were no differential impacts associated with the amount of the solicited subsidy. This result is consistent in all the specifications of the cluster analysis we implemented, and, therefore, it allows us to conclude that the LPP-1 did not produce any significant dosage effect.

On the basis of this evaluation, we recommend a deep revision of the mechanism of compensation of the facilitators and a reinforcement of

oversight activities carried out by the PCU. The review of the LPP rationale and operational design revealed some perverse incentives and conflicts of interest to which the facilitators were exposed and it made clear that the project was highly exposed to the risk of attracting rent-seekers if the pre-selection process coordinated by the facilitators was not properly monitored.

In addition, we also recommend considering a revision of the mechanism of disbursement of the matching-grant. The mechanism adopted by the LPP was highly illiquid, and, *de facto*, excluded from the project those producers that were not increasing their investment in technology adoption because of financial constraints.

Finally, on the basis of the impact evaluation, we recommend to base the scaling-up of the LPP on a more rigorous assessment of the project targeting. The lack of impact on the efficiency indicators could be due to a targeting problem, which would be consistent with the fact that we found evidence of a positive impact on efficiency only on producers with an initial orientation in breeding activity. A scaling up that includes different type of beneficiaries would incur the risk of not producing any significant impact on productivity indicators.

Potential extensions of this study would require additional data. To date, significant efforts have been made to collect microdata on the Livestock sector in Uruguay, data that facilitated the understanding of important aspects of this industry. However, the construction of a longer panel dataset would also allow assessing the sustainability of the impacts of policy such as the LPP.

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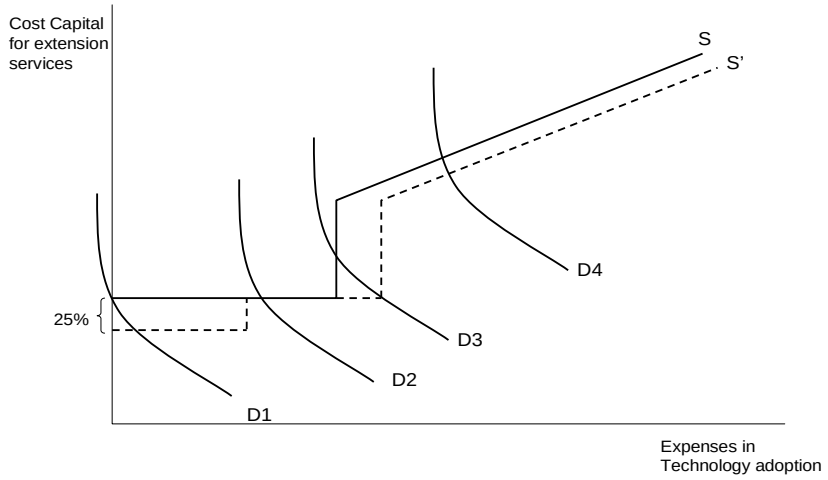
Appendix I:--The Effectiveness of the Matching-Grant Mechanism

Following Hall and Maffioli (2008), we assume that each producer faces a downward sloping demand for extension services and a supply cost of capital for extension that is flat until internal funds for extension are exhausted, and then jumps up to the cost of external funds, increasing as more and more external funds are needed. Absent the subsidies, each producer spends in extension services at the level where the demand and supply curves intersect. This situation is shown in Figures A1: the curve labeled S is the supply of funds, and D1 through D4 represent the demand for funds by producers with various levels of financial constraint.

Figure I-1
The Supply and Demand of Fund for Technology Adoption



Source: Adapted from Hall and Maffioli (2008).

The curve S' in Figure A1 illustrates the effect of a matching grant that lowers the cost of financing below the cost of internal funds for extension spending up to the amount of the grant and increases the point at which internal funds are exhausted by the amount of the matching grant. In the LPP-1 case, the subsidy matches the recipient spending for the 25% of the business up to US$ 7,000. The potential effect of this grant will vary for

the four different types of producers: producer 1 was not spending in extension before (or was spending very low), and the matching grant will induce her to undertake some extension service. Producer 2 will likely substitute the funds from the matching grant for its own and will not increase its spending on extension services, which is sometimes considered rent-seeking behavior. Producers 3 and 4 (slightly and strongly financially constrained) would probably find that their cost of capital has dropped on the margin and therefore ought to increase their investment significantly. However, the highly illiquid temporary structure of the LPP-1's disbursements would probably discourage them form participating: the subsidy, in fact, is paid only after demonstrating the attainment of objectives, which imply that the producer need to be not financially constrained for the full amount of the project they proposed.

Appendix II:--Empirical Results

Table II-1
Participation Model (*Logit Estimations*)

	M1	M2	M3	M4
Land Area (1000 has)	-0.993**	-0.961**	-0.964**	-0.957**
Montevideo=1	0.576	0.674*	0.661*	0.688*
CONEAT Index	-0.003	-0.003	-0.003	
Age of the Farmer (Years)	0.133**	0.139**	0.141**	0.137**
Age of the Farmer^2 (Years)	-0.002**	-0.002**	-0.002**	-0.002**
Undergraduate or Technical Studies=1	2.131**	1.617*	1.631*	1.614*
Farmer was involved in Activities Outside the Farm=1	0.433*	0.364*	0.377*	0.378*
Participated in another MGAP program=1	1.323**	1.225**	1.218**	1.229**
Reviewed the bulls=1	-1.812**	-1.756**	-1.776**	-1.771**
Diagnosis of Pregnancy=1	1.343**	1.312**	1.297**	1.308**
Productive Orientation (Breeders=1, Complete Cycle=0)				
Keep Register of Physical Events=1 *(2001)*	-0.125	-0.11		
Keep Register of Economic Events=1 *(2001)*	1.081**	0.98**	0.939**	0.880**
WP *(2001)*	-0.003			
Constant	-1.37	-1.717	-1.776	-1.894
Observations	708	734	736	744
Wald Chi^2	189.9	184.1	184.7	184.9
PseudoR^2	0.41	0.39	0.39	0.39

Notes: * significant at 10% level; ** significant at 5% level; *** significant at 1% level. Robust standard errors.

Table II-2
Covariates Balance Before and After Matching

Variable	Sample	Mean		% bias	% reduction	t	p-value
		Treated	Control				
Land Size (1000 has)	Unmatched	0.92	2.68	-88.7		-12.40	0.00
	Matched	0.92	0.80	6.3	92.8	9.58	0.00
Montevideo=1	Unmatched	0.13	0.04	33.6		4.48	0.00
	Matched	0.13	0.21	-25.8	23.3	-5.23	0.00
CONEAT Index	Unmatched	89.95	89.54	1.5		0.20	0.84
	Matched	89.95	90.20	-0.9	39.1	-3.09	0.00
Age of the Farmer (Years)	Unmatched	47.02	53.94	-53.9		-7.38	0.00
	Matched	47.02	46.22	6.2	88.5	6.17	0.00
Undergraduate or Technical Studies=1	Unmatched	0.06	0.01	22.5		3.00	0.00
	Matched	0.06	0.05	3.2	85.9	-1.63	0.10
Farmer was involved in Activities Outside the Farm=1	Unmatched	0.42	0.26	35.5		4.79	0.00
	Matched	0.42	0.50	-17	52.1	-5.34	0.00
Received Technical Assistance from a Private Agronomist=1	Unmatched	0.72	0.89	-44.2		-3.83	0.00
	Matched	0.72	0.80	-18.9	57.3	-1.09	0.28
Received Technical Assistance from a Private Veterinary=1	Unmatched	0.91	0.95	-19.1		-2.05	0.04
	Matched	0.91	0.89	5.5	71.2	1.40	0.16
Participated in another MGAP program=1	Unmatched	0.25	0.06	54.8		7.30	0.00
	Matched	0.25	0.20	16.2	70.4	-4.47	0.00
Reviewed the bulls=1	Unmatched	0.26	0.62	-77.8		-10.58	0.00
	Matched	0.26	0.37	-23	70.5	4.98	0.00
Productive Orientation (Breeders=1)	Unmatched	0.49	0.36	27.2		2.97	0.00
	Matched	0.49	0.48	4	85.2	-3.77	0.00
Keep Register of Physical Events=1 *(2001)*	Unmatched	0.71	0.71	-0.8		-0.11	0.91
	Matched	0.71	0.65	13.1	-1509.2	0.84	0.40
Keep Register of Economic Events=1 *(2001)*	Unmatched	0.79	0.73	13.4		1.82	0.07
	Matched	0.79	0.72	14.7	-9.7	-0.28	0.78
WP *(2001)*	Unmatched	66.73	66.07	5.2		0.71	0.48
	Matched	66.73	67.98	-9.9	-90.7	-1.61	0.11
Diagnosis of Pregnancy=1	Unmatched	0.62	0.52	20		2.71	0.01
	Matched	0.62	0.60	5.1	74.5	-3.51	0.00

Table II-3
Impact of the LPP-1 on Practices and Productivity
(*Whole Sample, in percentage points***)**

Whole Sample						
		Beneficiaries	**Non-Beneficiaries**	**Impact**	**Common Support**	
		Δ 2003-2001	**Δ 2003-2001**		**treated**	**untreated**
Register of Physical	unmatched	25.63	0.58	25.05		
Events	ATT	25.63	0.35	**25.29****	394	270
Register of Economic	unmatched	12.44	8.43	4.01		
Events	ATT	12.44	-6.30	**18.74****	394	270
WP	unmatched	3.69	5.18	-1.49		
	ATT	3.75	1.33	2.43	375	235
REI	unmatched	4.96	2.94	2.02		
	ATT	5.00	6.80	-1.80	315	129

Notes: **, * Significant at 5% and 10% respectively, one tailed test. Standard errors were obtained by bootstrap (500 iterations).

Table II-4
Impact of the LPP-1 on Practices and Productivity
(Breeders only, in percentage points)

Breeders						
		Beneficiaries	Non Beneficiaries	Impact		
		Δ 2003-2001	Δ 2003-2001		treated	Untreated
Register of Physical	unmatched	27.27	3.57	23.70		
Events	ATT	29.31	25.75	3.56	58	30
Register of Economic	unmatched	19.70	10.71	8.98		
Events	ATT	20.69	-2.12	**22.81****	58	30
WP	unmatched	3.31	-0.69	4.00		
	ATT	1.55	1.41	0.15	34	19
REI	unmatched	3.72	-1.43	5.15		
	ATT	1.71	-4.96	**6.67***	34	17

Notes: **, * Significant at 5% and 10% respectively, one tailed test. Standard errors were obtained by bootstrap (500 iterations).

Table A5
Impact of the LPP-1 on Practices and Productivity
(Complete Cycle only, in percentage points)

Exploitations of Complete Cycle						
		Beneficiaries	Non Beneficiaries	Impact		
		Δ 2003-2001	Δ 2003-2001		treated	untreated
Register of Physical	unmatched	14.93	6.54	8.38		
Events	ATT	18.75	2.98	**15.77***	48	72
Register of Economic	unmatched	7.35	13.08	-5.73		
Events	ATT	10.20	5.28	4.92	49	72
WP	unmatched	5.21	5.78	-0.57		
	ATT	3.43	10.90	-7.47	46	60
REI	unmatched	7.45	4.64	2.82		
	ATT	6.37	5.73	0.64	46	52

Notes: **, * Significant at 5% and 10% respectively, one tailed test. Standard errors were obtained by bootstrap (500 iterations).

Graph I-1
Graphical Representation of the Specialization Indicators

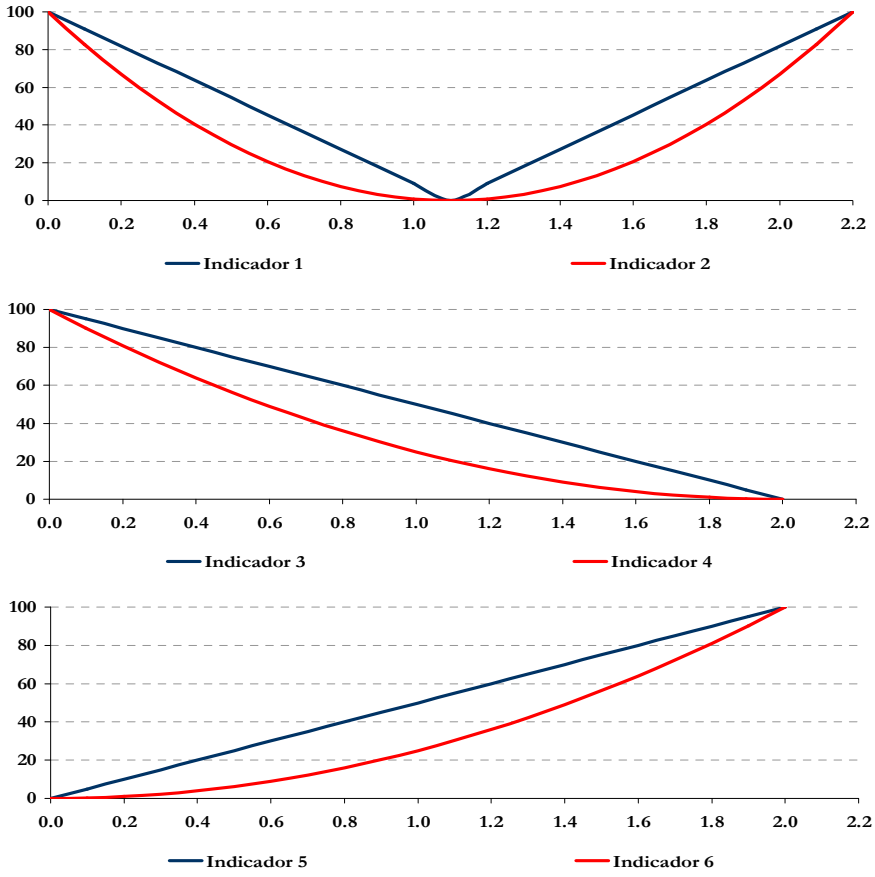


Table II-6
Impact of the LPP-1 on Absolute Specialization

SPI_1

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

SPI_2

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

Sample: Treated=400, Control=270

Table II-7
Impact of the LPP-1 on Specialization in Breeding (increase**)**

SPI_3

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

SPI_4

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

Sample: Treated=63, Control=16

Table II-8
Impact of the LPP-1 on Specialization in Breeding (decrease**)**

SPI_5

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

SPI_6

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

Sample: Treated=30, Control=8

Table II-9
Determinants of the Changes in Productivity (REI)

	Whole Sample	Common Support	Only Beneficiaries
Subsidy (MUS$)	0.90**	0.86**	-0.69
Land Area (1000 has)	-0.20	-1.48**	0.07*
Montevideo (=1)	1.47	1.36	2.28
Age (Years)	0.09	0.17	-0.15
Age^2 (Years)	0.00	0.00	0.00
Undergraduate or Technical Studies=1	2.93	3.34	2.51
Farmer was involved in Activities Outside the Farm=1	1.27	1.19	0.83
Participated in another MGAP program=1	3.32**	3.09**	1.34
Reviewed the bulls=1	0.30	0.26	0.57
Keep Register of Physical Events=1 *(2001)*	1.44	1.72	0.23
Diagnosis of Pregnancy=1	0.43	0.97	-0.45
REI *(2001)*	-0.69**	-0.66**	-0.82**
WP (2001)	-0.09	-0.08	-0.86
Constant	35.63**	32.66**	39.55**
R^2	0.33	0.29	0.32
Observations	504	468	373
F-Stat	17.4	13.5	13.7

Notes: **, * Significant at 5% and 10% respectively. Robust standard errors.

Table II-10
Determinants of the Changes in Productivity (WP)

	Whole Sample	Common Support	Only Beneficiaries
Subsidy (MUS$)	-0.23	-0.16	0.15
Land Area (1000 has)	-0.08	-1.53*	-1.85*
Montevideo=1	1.71	1.86	1.82
Age (Years)	-0.13	0.07	0.29
Age^2 (Years)	0.00	0.00	0.00
Undergraduate or Technical Studies=1	0.95	1.57	1.98
Farmer was involved in Activities Outside the Farm=1	1.12	1.10	0.56
Participated in another MGAP program=1	1.29	1.13	1.27
Reviewed the bulls=1	1.55	1.83	1.57
Keep Register of Economic Events=1 *(2001)*	2.29*	2.00	1.34
Diagnosis of Pregnancy=1	0.54	0.80	0.90
REI (2001)	0.03	0.01	0.00
WP (2001)	-0.82**	-0.80**	-0.68**
Constant	56.79**	52.98**	40.64**
R^2	0.38	0.36	0.25
Observations	513	474	373
F-Stat	20.6	17.2	11.6

Notes: **, * Significant at 5% and 10% respectively. Robust standard errors.

Table II-11
Clusters Beneficiaries by Subsidy Amount (*Basic statistics*)

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

Notes: Obtained from cluster Analysis K-Means using the Euclidean distance as similarity measure

Table II-12
Participation Model (*k=4 Groups, Ordered Logistic Regression*)

	Coefficient	**Probability**
Land Area *(1000 has)*	2.19	0.00
Coneat Index	-0.01	0.00
Undergraduate or Technical Studies=1	-0.80	0.10
Participated in another MGAP program=1	-0.39	0.05
WP *(2001)*	-0.03	0.03
Diagnosis of Pregnancy *(2001)*	0.50	0.01
Cut 1	-2.38	
Cut 2	-0.81	
Cut 3	0.67	
Observations		461
Chi^2		73.41
R^2		0.140

Notes: Robust standard errors.

Table II-13
Participation Model (*k=3 Groups, Ordered Logistic Regression*)

	Coefficient	Probability
Land Area *(1000 has)*	2.64	0.00
Coneat Index	-0.01	0.00
Undergraduate or Technical Studies=1	-0.96	0.14
Participated in another MGAP program=1	-0.28	0.16
WP*(2001)*	-0.03	0.02
Diagnosis of Pregnancy *(2001)*	0.47	0.01
Cut 1	-1.38	
Cut 2	0.42	
Observations		461
Chi^2		83.09
R^2		0.192

Notes: Robust standard errors.

Table II-14
Participation Model (*k=2 Groups, Logistic Regression*)

	Coefficient	Probability
Land Area *(1000 has)*	2.64	0.00
Coneat Index	-0.01	0.00
Undergraduate or Technical Studies=1	-0.96	0.14
Obs.		508
Chi^2		62.41
R^2		0.254

Notes: Robust standard errors.

Table II-15
Dosage Analysis (*k=4*)

Dosage 01				
		Beneficiaries	**Non-Beneficiaries**	**Impact**
		Δ 2003-2001	**Δ 2003-2001**	
Register of Physical Events	unmatched	28.83	21.18	7.65
	ATT	28.83	40.07	-11.24
Register of Economic Events	unmatched	13.89	9.52	4.37
	ATT	13.89	8.72	5.17
WP	unmatched	4.60	3.23	1.37
	ATT	4.60	5.15	-0.55
REI	unmatched	6.71	4.70	2.01
	ATT	6.71	5.55	1.17

Dosage 02				
		Beneficiaries	**Non-Beneficiaries**	**Impact**
		Δ 2003-2001	**Δ 2003-2001**	
Register of Physical Events	unmatched	31.36	21.18	10.18
	ATT	31.62	29.19	2.44
Register of Economic Events	unmatched	15.13	9.52	5.60
	ATT	15.25	13.28	1.98
WP	unmatched	5.07	3.23	1.84
	ATT	5.09	5.92	-0.83
REI	unmatched	4.67	4.70	-0.03
	ATT	4.69	4.75	-0.07

Dosage 03				
		Beneficiaries	**Non-Beneficiaries**	**Impact**
		Δ 2003-2001	**Δ 2003-2001**	
Register of Physical Events	unmatched	21.17	21.18	-0.01
	ATT	21.85	16.27	5.58
Register of Economic Events	unmatched	14.49	9.52	4.97
	ATT	15.97	9.38	6.58
WP	unmatched	3.46	3.23	0.23
	ATT	3.72	3.07	0.65
REI	unmatched	3.34	4.70	-1.36
	ATT	2.87	5.17	-2.30

Notes: Significant at 5% and 10% respectively, one tail test. Standard Errors were obtained by bootstrap (500 iterations)

Table II-16
Dosage Analysis (*k=3*)

Dosage 01				
		Beneficiaries	**Non-Beneficiaries**	**Impact**
		Δ 2003-2001	**Δ 2003-2001**	
Register of Physical Events	unmatched	28.83	21.18	7.65
	ATT	28.83	40.07	-11.24
Register of Economic Events	unmatched	13.89	9.52	4.37
	ATT	13.89	8.72	5.17
WP	unmatched	4.60	3.23	1.37
	ATT	4.60	5.15	-0.55
REI	unmatched	6.71	4.70	2.01
	ATT	6.71	5.55	1.17

Dosage02				
		Beneficiaries	**Non-Beneficiaries**	**Impact**
		Δ 2003-2001	**Δ 2003-2001**	
Register of Physical Events	unmatched	31.36	21.18	10.18
	ATT	31.62	29.19	2.44
Register of Economic Events	unmatched	15.13	9.52	5.60
	ATT	15.25	13.28	1.98
WP	unmatched	5.07	3.23	1.84
	ATT	5.09	5.92	-0.83
REI	unmatched	4.67	4.70	-0.03
	ATT	4.69	4.75	-0.07

Notes: Significant at 5% and 10% respectively, one tail test. Standard Errors were obtained by bootstrap (500 iterations)

Table II-17
Dosage Analysis (*k=2*)

Dosage 01				
		Beneficiaries	**Non-Beneficiaries**	**Impact**
		Change 2003-2001	**Change 2003-2001**	
Register of Physical Events	unmatched	24.45	27.31	-2.85
	ATT	24.77	28.43	-3.65
Register of Economic Events	unmatched	15.58	10.98	4.60
	ATT	16.07	11.83	4.24
WP	unmatched	3.86	4.42	-0.56
	ATT	4.33	2.12	2.21
REI	unmatched	3.97	5.36	-1.39
	ATT	4.29	4.20	0.10

Notes: Significant at 5% and 10% respectively, one tail test. Standard Errors were obtained by bootstrap (500 iterations)