RESEARCH PAPER

Participation determinants and impact assessment of the Institute of Agricultural Development (INDAP) credit program

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Abstract

G. Donoso, O. Melo, and E. Negrete. 2010. Participation determinants and impact assessment of the Institute of Agricultural Development (INDAP) credit program. Cien. Inv. Agr. 37(2): 87-99. This research estimates the impact of INDAP's Credit Program on the per hectare agricultural income of small agricultural producers. To accomplish this, a Treatment Effects Model (TEM) is employed to simultaneously estimate producer incomes and program participation functions, correcting for the potential presence of selectivity bias through the correlation between the errors of both functions. The results indicate that farmers of greater age present a higher disposition to participate in the program, but their interest decreases as their age increases. Additionally, producers who are acquainted with and evaluate the financial cost of credits as well as those producers whose income comes mainly from their land, who are landowners, present a greater family size and work greater land surfaces, present a greater disposition to participate. The results also indicate the existence of selection bias due to the nonrandom participation of farmers in the program. A negative correlation between the error terms of the per hectare agricultural income and participation function is observed. This implies that Ordinary Least Squares (OLS) underestimates the true effect of the program, because it omits the different initial situations between the treated and control group, situation corrected by the TEM estimation. In addition, the results indicate that there exists a positive and significant difference in the per hectare agricultural income between both groups in favor of the participants of the Credit Programs of INDAP, thus the Credit Program presents a positive impact on producer income levels.

Key words: Program impact estimation, selection bias, rural finance, treatment effects model.

Introduction

In Chile, as well as the world, an important discussion has arisen in regard to the effectiveness of programs and public policies oriented to overcome rural poverty. Among the main types of programs developed and implemented in re-cent decades are food subsides, money transfers, infrastructure investment and self-employment, with credit and technical assistance within the last category. All these instruments are oriented to reduce home vulnerability which is under the poverty line or close to it.

Regardless the efforts in regard to the resources oriented to these programs, the results are not as expected, partly due to the temporary solutions offered by the aforementioned instruments which do not allow effective reduction of rural

poverty (CEPAL, 2005). The non-accomplishment of expected results has promoted a change of approach in regard to the public administration, from an administration centered on inputs, understood as the control of budget resources and investment according to the established regulations and processes, to an administration based on results and centered on the effects created by government interventions. Thus, it is strongly necessary to undertake impact assessments to measure the changes in the individuals' welfare levels attributed to a program or to a specific public policy.

Microcredit in the agricultural sector, has presented a lower development than in the urban world due to specific characteristics of this sector. In addition, characteristics of the agricultural and rural sector, such as the development of informal markets, the lack of commercial references or history of commercial compliance, absence of accounting, lack of properties, record of sales and incomes, among others, worsen this situation.

This has caused a shortage of private financing for small farmers, and, thus, the State has taken an active role in providing this service with credits granted directly to small agricultural producers through INDAP.

The credit policy of INDAP indicates that the credit given to small agricultural producers is a productive instrument focused on the development of agricultural productivity, in order to reach economic, social and technological development (INDAP, 2004).

There are different methodological designs for an impact evaluation of public programs. The quantitative methods of evaluation use the comparison technique to determine the causality between the intervention of the program and the changes experimented by the beneficiaries, where answering the question of how the beneficiaries would have been if they had not participated in the program is essential in this approach.

This question cannot be answered with the information available, since it is not possible to observe the characteristics that a person would have had if they had not participated in the program. Due to the aforementioned, it is necessary to build a counterfactual scenario based on a group of people with similar characteristics to the people who have participated in the program, generating what is called a control group, measuring the impact through the comparison of both groups according to specific variables of interest.

On the other hand, it is important to point out that the group of participants in the program is not the result of a random selection process, and, thus, a selection bias is characteristic of this group if it is not controlled. This selection bias leads to an under or overestimation of the impact of the program, regardless the identification of a control group of similar observable characteristics.

Therefore, the objective of this research is to identify the participation determinants in the Credit Program of INDAP, to clarify the existence or inexistence of selection biases between beneficiaries and non-beneficiaries of the program and to estimate the impact of the program on the per hectare agricultural incomes of the beneficiaries. Thus, a Treatment Effect Model (TEM) is estimated to assess the impact of the program on the per hectare agricultural incomes of the credit program participants.

The document is divided in four sections including this section. The second section describes and explains the methodology used and the reason of its application, and presents the descriptive statistics of the data used. The estimations corresponding to the participation determinants, selection bias and impact of the program are presented in the third section. Finally, the conclusions of the study are presented.

Materials and methods

An impact evaluation is a study intended to measure the changes in individual welfare which may be attributed to a specific program

or policy (Banco Mundial, 2003). The impact of the program is given by:

$$\Delta_i = Y_{1i} - Y_{0i} \qquad (1)$$

where Δ_i represents the impact of the program on the person i, Y_{1i} is the result variable representing the income in the treatment status and indicating the conditions reached by the individual participating in the program, and Y_{0i} represents the income that the same individual might have reached in absence of the program. Therefore, the impact of the program expressed may not be observed directly, as only one of two conditions is observed for each individual in a specific moment. In order to carry out this evaluation, it is necessary to consider the use of a control group of similar characteristics to the treated group, which is called counterfactual scenario.

In general, the participants of a program respond to some criteria of selection or specific characteristics that make them different to the control group. It is necessary to control for this selection bias in the impact evaluation of a program. The use of Sample Selection Models or Models of Selective Truncation, from which the Treatment Effect Model (TEM) derives, corrects this problem by the inclusion of a participation function (Heckman AND Hotz, 1989 AND Heckman, 1997). The use of the TEM to estimate the impact of the Credit Program of INDAP is justified on the information available and the specific characteristics of the program.

The TEM is an extension of the model of sample selection developed by Heckman (1979) which is intended to correct the sample truncation by a function expressing the participation of a specific program, generating the following expression (Greene, 1999):

$$Y_i = \beta X_i + \alpha d_i + e_i, \qquad (2a)$$

where Y_i is the per hectare agricultural income of the i-th individual, X_i is a vector of observable characteristics of the individuals from groups with and without treatment, β is a parameter to estimate, α is a mean effect of the program on the participants, and e_i represents the disturbances on the function of per hectare agricultural income. On the other hand, d_i is a binary decision variable, from an unobserved latent variable d_i^* defined by:

$$d_i^* = \gamma W_i + u_i \text{ with, } d_i = 1 \text{ si } d_i^* > 0 \qquad (2b)$$
$$d_i = 0 \text{ in other case}$$

where W_i is a vector of observable characteristics determining the participation in the program, γ are parameters to estimate and u_i represents the conjoint of non observables characteristics of the participation function.

The sampling decision rule (2b) mentioned above determines that $E(Y_i/X_i, d_i^* > 0) = \beta X_i + \alpha d_i + E(e_i/d_i^* > 0)$, therefore, the conditional mean of e_i is not zero. In order to solve this problem, the TEM model introduces the Mill's inverse ratio (λ_i) in the per hectare agricultural income function, which reflects the probability that the i-th individual participates in the program controlling the effect of sample selection (Heckman, 1979, 1997).

Under the TEM model, the difference in the expected per hectare agricultural income between the participants and non-participants in the program is:

$$E[Y_i/d_i = 1] - E[Y_i/d_i = 0] = \alpha + \rho \sigma_e \lambda(\gamma W_i) \qquad (3)$$

If the correlation (ρ) between the errors of the per hectare agricultural income function (e_i) and the participation function (u_i) is equal to zero, that is, if there is no selection bias, the estimation of the difference in per hectare agricultural income simply involves the estimation of α with Ordinary Least Squares (OLS).

The TEM requires the previous identification of the attributes defining the participation in the Credit Program of INDAP, whose influence in the per hectare agricultural income function is through the Mill's inverse ratio. Thus, a participation decision in the INDAP Program is estimated through a Probit model. The variables of interest of the participation model have been grouped according to the fol-

lowing categories:

a) Personal characteristics of the house owner: age, gender, size of the family group, ethnic origin and educational level.

b) Physical and productive characteristics of the home: size of the land and type of ownership.

c) Administrative management: farmer evaluation or non-evaluation of financing costs and the main source of income.

Stata 9.0 is used for the estimation of this model, which includes syntaxis to estimate the parameters of the equations (2a) and (2b), either by maximum likelihood or the two stage Heckman methodology (STATA, 2003).

The data used in the present study corresponds to a representative survey of 1,510 small farmers who are beneficiaries of INDAP's Credit Program, from a total of 41,227 program participants that applied between December 2004 and January 2005, covering a total of 72 municipalities, and in a sample that covered the III, IV, V, VI, VII, VIII, IX, X and Metropolitan Regions. The survey was applied through personal interviews, and groups of 14 surveyors were defined for the group of beneficiaries and 7 surveyors for the control group. The sample is divided in two thirds for a group of INDAP beneficiaries who received more than one credit between 2000 and 2003, and one third for a control group composed by farmers who do not present INDAP credits in the same period. For the Control Group, small farmers belonging to the INDAP client portfolio who did not receive any credit from INDAP in the study period

are considered in the sample. To generate the sample of members of the control group and the study group, databases from INDAP area agencies were used.

Results and discussion

The survey applied collected information regarding sociodemographic information of the user, descriptors of productive activity and agricultural and non-agricultural incomes. Information related to the continuous variables used in the study is presented in Table 1. The variables age and size of the family group present similar behavior in both groups, unlike land surface, where the participants in the program exceed non- participants by two hectares on average. In addition, a higher data dispersion of the untreated group land surface is observed. In this regard, it is important to point out the fact that the total number of observations is lower than 1,510, because some variables do not present values for all the observations, and the descriptive parameters are estimated with the total number of observations with complete information.

Table 2 shows the behavior of the variables educational level and land surface that farmers have at a national and regional level. More than 50% of the farmers of the total sample have incomplete elementary school, followed by complete elementary school, with almost 70% of the sample in both categories combined.
In the Third Region, the total of farmers with incomplete and complete elementary school does not exceed 50% of the surveyed group, distributing a higher proportion in the categories

Table 1. Continuous variables summary statistics.

Variable	Treated			Mot treated		
	Observations	Average	Standard Deviation	Observations	Average	Standard Deviation
Hectares (ha)	987	9.2	15.4	485	7.3	32.7
Age (years)	953	53.5	13.0	471	52.3	13.9
Family Size (Nº)	983	4.2	1.8	485	4.0	1.9

Table 2. Average surface and number of farmers per Region and educational level.

Regions	Variables	No Education	Incomplete Primary	Complete Primary	Incomplete High School	Complete High School	Higher Education	No information	Total Survey
					Niveles educacionales				
3	Num.	1	15	4	7	11	4		42
	ha	0.5	1.1	2.3	3.0	2.2	2.7		2.0
4	Num.	1	30	13	8	9	2		63
	ha	1	0.8	1.8	0.5	2.28	2		1.2
5	Num.	11	43	9	8	12	1		84
	ha	2.6	1.6	1.2	2.5	0.6	1.0		1.6
6	Num.	8	36	34	8	12	7		105
	ha	6.9	5.4	5.6	3.9	3.1	7.7		5.4
7	Num.	11	107	33	24	25	10	19	229
	ha	4.6	3.7	6.0	1.9	3.7	5.8	1.7	3.8
8	Num.	11	146	47	26	35	2	8	275
	ha	7.3	8.1	5.5	5.0	5.0	14.5	4.8	6.9
9	Num.	9	164	34	35	22	8	1	273
	ha	10.5	9.9	12.8	15.0	11.4	20.2	3.5	11.3
10	Num.	12	234	56	20	26	5	22	375
	ha	8.1	16.1	11.4	10.1	19.8	11.3	24.8	15.6
13	Num.	2	24	18	11	8	1		64
	ha	0.8	2.2	2.7	3.7	2.8	2.0		2.6
Total	Num.	66	799	248	147	160	40	50	1510
	ha	6.2	9.2	7.5	7.1	7.3	9.8	13.3	8.6

of complete high school and higher education. It is a totally different scenario in other regions since both categories exceed 50% of the sample.

At the national level, the average surface in hectares of land does not show significant differences according to the educational level of the farmers. This ranges from average 6.2 hectares for those who indicate an absence of formal education, to 9.8 hectares for those who have reached a higher education. However, there are uneven situations within each Region. For example, the largest surfaces in Regions VIII and IX are owned by farmers with higher education, while the farmers in the VI Region, both without education and with higher education have the largest land surfaces.

In addition, variability in land size per Region is observed. In this regard, farmers of the X Region present the highest average of hectares, reaching 15.6 hectares, while the opposite occurs in the IV Region, with 1.2 average hectares per farmer.

There is a positive relation between the educational level of the farmers and their annual agricultural incomes. Farmers with more years of formal studies present higher annual agricultural incomes. This relation is clearer in the group of farmers participating in INDAP compared to the group that do not participate. In regard to the origin of the incomes, the data indicates that for farmers who are customers of INDAP and for the control group, land represents their main source of income.

The estimation of the participation model is presented in Table 3. The estimation is made with 1,353 observations, which corresponds to the total number of observations with complete information for the variables considered in the

participation model. In order to determine the quality of fit of the participation model, the participation in the program with the model was predicted. The results of the predictions of participation indicated that the estimated model predicts correctly the participants or non-participant farmers in the program 77.1% of the times, indicating an adequate fit of the participation model. That is, from the total sample used corresponding to participants and non-participants in the Program (1,353 obser-

vations), the coincidence in the prediction of non-participation is 104 cases and the coincidence of prediction of participation is 939 cases (Table 4).

Age and family size are the unique personal characteristics discriminating who participated in the program. In regard to age, the results indicate that the higher the age, the more possibility to request a credit; however, this marginal effect decreases.

Table 3. Estimates of the Probit model for INDAP credit program participation.

Number of obs   =   1353
LR chi^2(23)   =   119.29
Prob > chi^2 =   0.0000
Pseudo R^2 =   0.0693
Log likelihood = -800.86263

Variable	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Age	0.0343671	0.0182331	1.88	0.0590	-0.0013690	0.0701033
Age squared	-0.0003096	0.0001672	-1.85	0.0640	-0.0006373	0.0000181
Has	0.0141272	0.0037976	3.72	0.0000	0.0066841	0.0215704
Ownership	0.1492258	0.0819773	1.82	0.0690	-0.0114467	0.3098983
Cost evaluation	0.5237209	0.0824898	6.35	0.0000	0.3620439	0.6853979
Income source	0.4540027	0.0866214	5.24	0.0000	0.2842279	0.6237774
Family size	0.0472540	0.0208965	2.26	0.0240	0.0062977	0.0882103
Etnia	0.0391168	0.1204545	0.32	0.7450	-0.1969697	0.2752033
Sex	0.1014872	0.0905072	1.12	0.2620	-0.0759036	0.2788780
Inc. Primary Complete	-0.0687387	0.1830512	-0.38	0.7070	-0.4275125	0.2900352
Prymary	-0.0841420	0.2074201	-0.41	0.6850	-0.4906780	0.3223940
Inc. High school	-0.1720888	0.2186994	-0.79	0.4310	-0.6007318	0.2565541
Complete High school	-0.1191724	0.2205179	-0.54	0.5890	-0.5513796	0.3130347
Higher education	-0.2600561	0.2886336	-0.90	0.3680	-0.8257676	0.3056554
No information on education	-0.3872113	0.3279877	-1.18	0.2380	-1.0300550	0.2556327
Region 4	0.0516070	0.2872362	0.18	0.8570	-0.5113657	0.6145797
Region 5	-0.0203140	0.2602309	-0.08	0.9380	-0.5303572	0.4897293
Region 6	0.2770628	0.2568803	1.08	0.2810	-0.2264134	0.7805390
Region 7	0.1315659	0.2345704	0.56	0.5750	-0.3281836	0.5913154
Region 8	0.0796817	0.2293284	0.35	0.7280	-0.3697937	0.5291572
Region 9	0.3488319	0.2518509	1.39	0.1660	-0.1447867	0.8424506
Region 10	0.3585507	0.2344303	1.53	0.1260	-0.1009242	0.8180256
Region 13	-0.0734759	0.2774913	-0.26	0.7910	-0.6173488	0.4703970
_Intercept	-1.5348090	0.5700156	-2.69	0.0070	-2.6520190	-0.4175990

Table 4. Participation model predictions.

	Observed		Total
Predicted	0	1	
0	104	71	175
1	239	939	1178
Total	343	1010	1353

The variable "size of the family group" (tgfa-miliar) is significant in explaining the participation in the program with a 95% confidence level, where the farmers with more numerous families are more interested in requesting a credit.

With regard to the category of physical and productive assets, land surface (ha) is a significant variable with a 99% confidence level in explaining the participation in the program. When land surface is increased, the probability of participating in the program increases as well. On the other hand, land ownership is a determinant participation variable, as it is a significant variable with a 90% confidence level; being an owner of agricultural land increases the probability of participation.

Within the category of administrative management, the two variables are significant with a 99% confidence level. The artificial binary variable "cost evaluation" shows that the farmers with higher probabilities of requesting a credit are those who evaluate the financing cost involved in the credit before requesting it. This higher predisposition or interest from participating farmers may be related to the knowledge of how in general the financing systems works, perhaps they have previous experience or they have been informed in INDAP offices. This situation is reflected in the fact that around 70% of the approved credits by INDAP correspond to old clients, that is, they have requested a credit and know the system.

Within this category, the variable "main source of income" (fuenteing) also results significant at a 99% confidence level. This is an artificial binary variable discriminating in favour of those whose main source of income is the land. This would indicate that the program might be applied to those who are effectively complying with one of the conditions necessary to be IN-

DAP clients, according to its Organic Law (INDAP, 2004)

The results of the estimation of the agricultural income per hectare with the TEM model (equation 2a) are presented in Table 5, where the per hectare agricultural income has been modelled based on the following variables: a) program (prog) takes the value of 1, if the farmer participates in the program, and 0, if he does not, b) educational levels where the incomplete elementary school is included (edubasicaincom), complete elementary school (edubasicacom), incomplete high school (edumediaincom), complete high school (edumediacom) and higher education (edusuperior), c) gender, that takes the value of 1 if it is about a man, and 0 if it is about a woman, d) land size (has and has^2) (ha^2 was included in the model so as to allow for non-constant marginal impacts of the surface on the per hectare agricultural income), e) from the III to the X Region, where the Region 13 corresponds to the Metropolitan Region and f) the variable ethnic group that takes on the value of 1, if the farmer belongs to some ethnic group and 0, in an opposite case. The number of observations considered in the estimation of the equation 2a is 1,183, which corresponds to the total number of observations with complete information, for the variables considered in the TEM model. The participation function in INDAP is included in the TEM model with the variables that were significant in the Probit model previously estimated.

The results indicate that the participation in the INDAP program is significant in explaining the per hectare agricultural income with a 99% confidence level. The positive sign indicates that the Credit Program of INDAP has a positive impact on per hectare agricultural income. That is, small farmers who are beneficiaries of the Credit Program of INDAP reach higher levels of per hectare agricultural income than small farmers who are not beneficiaries of INDAP. This result is coherent with other studies that show that the participation in INDAP contributes to intensify agricultural production, by increasing the use of inputs and agricultural family labor, which results in a significant increase in agricultural income of small and medium farmers

Table 5. TEM regression results.

Number of obs	1183					
Wald chi²(19)	1378.15					
Prob > chi²	0.0000					
Log likelihood	-2.526					
Variable	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Ecuación de Impacto						
ha	-0.0754325	0.0055985	-13.47	0.0000	-0.0864053	-0.0644596
ha²	0.000354	0.0000369	9.59	0.0000	0.0002817	0.0004263
etnia	-0.3006382	0.1094646	-2.75	0.0060	-0.5151848	-0.0860916
sex	-0.1097368	0.0842694	-1.30	0.1930	-0.2749019	0.0554282
Inc. Primary	0.1800458	0.166089	1.08	0.2780	-0.1454826	0.5055743
Complete Prymary	0.3563612	0.1805353	1.97	0.0480	0.0025184	0.7102039
Inc. High school	0.644058	0.1953769	3.30	0.0010	0.2611263	102.699
Complete High school	0.5251922	0.1870033	2.81	0.0050	0.1586726	0.8917119
Higher education	0.7843398	0.2521811	3.11	0.0020	0.290074	1.278.606
No information on education	0.384159	0.2966243	1.30	0.1950	-0.197214	0.9655321
Region 4	0.9312898	0.2505336	3.72	0.0000	0.4402529	1.422.327
Region 5	0.5713959	0.2217018	2.58	0.0100	0.1368684	1.005.923
Region 6	-0.7967653	0.2201304	-3.62	0.0000	-1.228.213	-0.3653176
Region 7	-0.4752899	0.2002134	-2.37	0.0180	-0.8677009	-0.0828789
Region 8	-1.1877460	0.1966421	-6.04	0.0000	-1.573.158	-0.8023348
Region 9	-2.3278520	0.2168773	-10.73	0.0000	-2.752.924	-190.278
Region 10	-1.2108060	0.202352	-5.98	0.0000	-1.607.409	-0.8142038
Region 13	-0.6509102	0.2378787	-2.74	0.0060	-1.117.144	-0.1846765
prog	0.9574640	0.2293697	4.17	0.0000	0.5079076	140.702
_intercept	1.2874960	0.2885211	44.62	0.0000	1.230.947	1.344.045
Model Participation						
Age	0.0427171	0.018883	2.26	0.024	0.0057072	0.0797271
age²	-0.0003794	0.0001752	-2.17	0.030	-0.0007227	-0.0000361
Ha	0.0211025	0.0043128	4.89	0.000	0.0126495	0.0295555
ownership	0.1227363	0.0811637	1.51	0.130	-0.0363417	0.2818143
evacosto	0.2943943	0.0811415	3.63	0.000	0.1353599	0.4534287
income source	0.4416123	0.0861606	5.13	0.000	0.2727407	0.6104839
family size	0.0313309	0.0217476	1.44	0.150	-0.0112936	0.0739555
_Intercept	-1.4082320	0.5016282	-2.81	0.005	-2.3914050	-0.4250586
rho	-0.3878989	0.1051798			-0.5730049	-0.1651375
sigma	1.1932650	0.0385231			1.1201010	1.2712090
lambda	-0.4628664	0.1373645			-0.7320958	-0.1936369
LR test of indep. eqns. (rho = 0):			chi²(1) =	7.53	Prob > chi² =	0.0061

(Comisión Interministerial de Fomento Productivo, 1998; Edmonds, 1998; López, 1996; World Bank, 1994).

On the other hand, with regard to the determinants of per hectare agricultural income, results indicate that the binary complete elementary school variable is significant with a 95% confidence and the levels of incomplete high school, complete high school and higher education are significant with a 99% confidence level, indicating that, per hectare agricultural incomes increase with higher education. The level of incomplete elementary school is not significant in explaining per hectare agricultural incomes. These results are coherent with López (1996) results, which concluded that there is a strong causality relation between school level and incomes. His results indicate that the access to at least some high school and higher education are important factors associated to the highest per hectare income levels; however, the access to elementary school has no effect on incomes. In fact, the access to elementary school, without a complementary high school, does not exert a significant effect on income.

The geographic location of the producer's land is significant in explaining the per hectare agricultural income with a 95% confidence level. Agricultural lands located in the IV and V Regions present higher incomes than lands located in the III Region, with a coefficient 0.93 and 0.57, respectively, while other regions present lower levels of per hectare agricultural income levels, compared to the III Region. This is coherent with the results obtained by the Comisión Interministerial de Fomento Productivo (1998), which found that participation in INDAP increases the agricultural incomes of small producers, but this impact is differentiated by regions.

The size of the land is a significant variable with a 99% confidence level. The marginal effect of this variable, measured in the mean values of the land size, is negative, which indicates that the farmers working in larger lands generate a lower per hectare income. This effect decreases as the surface is larger and, in fact, the marginal effect is positive for lands larger than 110 hectares. This is not coherent with the findings of López (1996) who found that the elasticity of land surface, with respect to income, is 0.07, which suggests that for an increase of 10% in land surface, income increases, on average, in 0.7%. It is noteworthy to mention that the study by López (1996) uses per capita income, while the present work uses the per hectare agricultural income; therefore, they are not directly comparable. Thus, the impact of the surface on the agricultural income per hectare requires deeper research and study.

These results are coherent with the results obtained by Edmonds (1998) who conducted his study with panel data from 250 small farmers in the province of Ñuble, who were surveyed in 1987 and again in 1995. The data allowed the comparison of small beneficiaries and non-beneficiaries of the INDAP program of technology transference (PTT) through time. Edmonds (1988) concluded that the participation in the INDAP program has had a positive and significant effect on the agricultural and family incomes. The program motivated small farmers to adopt nitrogen fixing legumes, but without significant impacts on yields or on the probability that small farmers use certified seeds or apply fertilizers. The main mechanism through which INDAP programs increased agricultural incomes was through an intensification of agricultural production.

Another study by the World Bank (1994), which was part of a strategic review of the rural and agricultural sectors, found that the annual income of INDAP participants, in a Region characterized by low family incomes and a high incidence of rural poverty, was US$ 1,200 higher than the annual incomes of the small producers who are not participants.

The study of the Comisión Interministerial de Fomento Productivo (1998) also found that the impact of participation in INDAP on family in-

come was very low or null in the cases where the agricultural income represented less than 50% of total income. This is associated to zones where there are only a few agricultural alternatives of development. In this regard, it is important to point out that income provided by agricultural activities represents less than 50% of the total household incomes in more than 50% of the agricultural producers with between 2 to 12 hectares of basic irrigation (Echeñique and Romero, 2009). This result supports the focalization of the Credit Program of INDAP in those exploitations where the main source of income comes from agricultural exploitation.

The qualitative evaluation of the INDAP impact on incomes made by MIDEPLAN (MIDEPLAN, 1994) found that the impact depends on the incomes of small farmers. For example, 46% of the small farmers with high incomes think that participating in INDAP increases their incomes, while only 22% of small farmers with low incomes consider that their participation generated higher incomes. Therefore, INDAP effects on income depend on the initial level of incomes of small farmers.

On the other hand, a study conducted by López (1996), based on a survey of approximately 1.000 small farmers, concluded that INDAP had a significant impact on the per hectare productivity, total production, proportion of total income from agriculture and the proportion of total labor that the home owner assigned to agricultural activities. However, the same study concluded that in 1994, the total per capita income was not affected by the participation in the program. The author suggests that the increased productivity per hectare is offset by the reduction of non-agricultural income, and also because the increased production occurs in less profitable crops.

In addition, this result is compatible with the results found by López (2000) in an evaluation of INDAP's impact on the income of small farmers. Although the same study also found a positive and significant impact of INDAP programs on agricultural production, there is not a clear impact on total income of the homes and states that a possible explanation is the deviation of

human resources from the generation of non-agricultural incomes, an increase of the production costs and a bias to less profitable crops. However, at least and with regard to the impact of the agricultural credit program, INDAP programs would increase agricultural incomes, opposed to the suggestions from López (2000), where a possible selection bias in the income equation is not considered.

Furthermore, belonging to an ethnic origin negatively affects per hectare income with a 99% confidence level. On the other hand, the variable gender of the home owner is not significant; therefore, per hectare agricultural income is not affected by gender.

The variables age, squared age, hectares (ha), evaluation costs and main source of income are significant in the program participation probability with a 95% confidence level, showing coherent results with the estimation of the Probit model, while the ownership and the size of the family group are not significant.

Additionally, the ρ, σ y λ values are presented in Table 5. The ρ coefficient indicates the correlation between the error term "e_i" of the result equation (2a) and the error term "u_i" of the participation function (2b). The results indicate the presence of bias by autoselection, because the coefficient value ρ is negative and significantly different from zero, with a 99% of confidence level. This implies that the impact of the INDAP's Credit Program cannot be estimated through Ordinary Least Squares, as the presence of autoselection bias generates biased parameter estimates.

The results of the estimation of equation (2a) are shown in Table 6 compared with Ordinary Least Squares (OLS) estimates, with 1.257 observations, corresponding to the total number of observations with complete information. First, it is important to state that the estimated OLS coefficients may not be interpreted, because they are biased estimators due to the presence of autoselection bias. Nevertheless, it is noteworthy to indicate that the parameter estimate signs are coherent with the results found with the TEM estimation. As pointed

out previously, the existence of a negative correlation between the error terms of the income and participation functions, leads to an underestimation of the program's effect on per hectare agricultural income estimated with Ordinary Least Squares (OLS), because it omits the uneven initial situation between the treated and the control group, which is corrected by the TEM estimation.

We may conclude from the results obtained in this research that the participation of the beneficiaries in the Credit Program of INDAP is determined by age, the evaluation of financing costs of a credit, incomes mainly from land work, land property, land surface and the size of the family group. From this result, the evalu-

ation of financing costs, main source of income and hectares are the most robust variables, as they maintain their significance for different model specifications and the fact of being an owner and the evaluation of financing costs are most relevant variables in the definition program participation.

The results of the TEM model indicate the presence of autoselection bias, because the ρ coefficient measuring the correlation between the error term of the function result "e_i" and the error term of the participation function "u_i" is negative and significantly different from zero. Consequently, we may point out that the per hectare agricultural income is not independent of the program participation decision.

Table 6. OLS regression estimates.

Number of obs	1267
F(19. 1247)	79.1
Prob > F	0.0000
R-squared	0.5466
Adj R-squared	0.5397

Variable	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
has	-0.0686213	0.0047566	-14.43	0.0000	-0.077953	-0.0592895
has^2	0.0003304	0.0000329	10.04	0.0000	0.0002658	0.0003949
etnia	-0.3321969	0.1069797	-3.11	0.0020	-0.5420769	-0.1223168
sex	-0.0934518	0.0808753	-1.16	0.2480	-0.2521185	0.0652149
prog	0.2083412	0.0704966	2.96	0.0030	0.0700361	0.3466463
Inc. Primary	0.2617998	0.1586797	1.65	0.0990	-0.0495088	0.5731084
Complete Prymary	0.4260172	0.172123	2.48	0.0130	0.0883345	0.7636999
Inc. High school	0.6813734	0.1860991	3.66	0.0000	0.3162715	1.0464750
Complete High school	0.6069682	0.1792768	3.39	0.0010	0.2552508	0.9586856
Higher education	0.8752783	0.2472071	3.54	0.0000	0.3902906	1.3602660
No information on education	0.3443423	0.2403017	1.43	0.1520	-0.1270979	0.8157825
Region 4	0.8590929	0.2445524	3.51	0.0000	0.3793134	1.3388720
Region 5	0.4627784	0.2175265	2.13	0.0340	0.0360200	0.8895368
Region 6	-0.8643001	0.2169887	-3.98	0.0000	-1.2900030	-0.4385968
Region 7	-0.4924017	0.1970944	-2.5	0.0130	-0.8790748	-0.1057285
Region 8	-1.2166360	0.1948204	-6.24	0.0000	-1.5988470	-0.8344238
Region 9	-2.4310500	0.211448	-11.5	0.0000	-2.8458840	-2.0162170
Region 10	-1.3050060	0.1968248	-6.63	0.0000	-1.6911500	-0.9188612
Region 13	-0.6981500	0.2299768	-3.04	0.0020	-1.1493340	-0.2469659
_intercept	1.3319430	0.2438231	54.63	0.0000	1.2841080	1.3797780

Resumen

G. Donoso, O. Melo y E. Negrete. 2010. Determinantes de participación e impacto del programa de crédito del Instituto de Desarrollo Agropecuario (INDAP). Cien. Inv. Agr. 37(2): 87-99. En el presente trabajo se evalúa el impacto del Programa de Crédito de INDAP en el ingreso de pequeños productores agrícolas. Para esto, se aplica el Modelo de Efecto de Tratamiento (MET) que entrega en forma simultánea los estimadores de la función de ingreso y la función de participación, midiendo el efecto del programa y detectando la presencia de sesgo de selección a través de la correlación entre los errores de ambas funciones. Los resultados señalan que los agricultores de mayor edad presentan una mayor disposición a participar en el programa pero cuyo interés decrece a medida que su edad aumenta, además, presentan mayor disposición a participar aquellos agricultores que conocen y evalúan los costos financieros de un crédito, los productores cuyos ingresos provienen principalmente del predio, los propietarios, los agricultores con un tamaño familiar más numeroso y aquellos que explotan mayores superficies. Lo anterior entrega una primera señal de la existencia de potenciales sesgos de selección, resultado de la participación no aleatoria de los agricultores en el programa y que diferencia a los participantes en el programa del grupo de control. Se observa la existencia de correlación negativa entre los términos de error de las funciones de ingreso y participación. Esto indica que los agricultores que participan en el programa presentan características no observables que los diferencian del grupo de control, y que determinan a su vez una mayor propensión a participar en el programa afectando el ingreso. Esto tiene como consecuencia que el efecto del programa en el ingreso estimado con Mínimos Cuadrados Ordinarios (MICO) subestima el efecto del programa, debido a que omite la situación inicial dispar entre los tratados y el grupo de control, situación que es corregida por la estimación realizada con MET. Se concluye además que la diferencia en el ingreso estimado entre ambos grupos es positiva y significativa en favor de los participantes del Programa de Crédito de INDAP, teniendo el programa un rol más preponderante en agricultores que trabajan con menos hectáreas y poseen menos educación formal.

Palabras clave: Sesgo de selección, microcrédito rural, efecto de tratamiento.

References

Banco Mundial, 2003. The contribution of social protection to the Milenium Goals. Available online at: http://www.worldbank.org (Website accessed: 2 August, 2007).

CEPAL, 2005. Manual para la evaluación de impacto de proyectos y programas de lucha contra la pobreza. Serie manuales, Área de proyectos y programación de inversiones. Santiago, Chile.

Comisión Interministerial de Fomento Productivo, 1998. Evaluación de Instrumentos de Fomento Productivo. El Programa de Transferencia de Tecnología de INDAP. Ministerio de Agricultura y Ministerio de Economía. Santiago, Chile.

Echeñique, J., and L. Romero. 2009. Evolución de la Agricultura Familiar en Chile en el Período 1997 -2007. FAO Chile 122 pp.

Edmonds, C.M. 1998. Policy regimes, agrarian institutions, and the performance of smallholder agriculture in Chile: three essays analyzing longitudinal survey data on Chilean peasant farms. Thesis (Ph.D. in Agricultural and Resource Economics), University of California, Berkeley, May 1998.

Greene, W. 1999. Análisis Econométrico. Tercera Edición, Prentice Hall Inc. Madrid, España. 913 pp.

Heckman, J. J. 1979. Sample selection Bias as a specification error. Econometrica 47(1):153-161.

Heckman, J. J. 1997. Instrumental Variables: A study of implicit behavioral assumptions used in making program evaluations. The Journal of Human Resources 32(3): 441-462.

Heckman, J. J., and V. J. Hotz. 1989. Choosing among alternative nonexperimental methods for estimating the impact of social programs: The Case of Manpower Training. Journal of the

American Statistical Association 84 (804): 862 – 874.

INDAP, 2004. Normas para operar el programa de créditos de INDAP. Instituto de Desarrollo Agropecuario (INDAP). Santiago, Chile.

López R. 1996. Determinantes de la pobreza rural en Chile: Programas públicos de extensión y crédito, y otros factores. Cuadernos de Economía 33 (100): 321-343.

López, R. 2000. Determinants of Rural Poverty in Chile: Evaluating the Role of Public Extension/ Credit Programs and Other Factors. In: López, R and A. Valdés (eds.). Rural Poverty in Latin America. St. Martin Press, LLC. New York.

MIDEPLAN. 1994. Informe final: Opinión de los beneficiarios del Programa de Transferencia Tecnológica de INDAP. Ministerio de Planificación y Cooperación (MIDEPLAN), Santiago, Chile.

Stata 2003. Stata Base Reference Manual. Stata Press.

World Bank. 1994. Chile. Strategy for rural areas. Enhancing agricultural competitiveness and alleviating rural poverty. Report N 12776-CH of the Natural Resources and Rural Poverty Division. Washington DC, USA. The World Bank. p. 54.