The Effect of Genetic and Infrastructure Investments in Dairy and Beef Producers' Profit in Chile

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Abstract

The objective of this study was to evaluate the effect of infrastructure and genetic improvement investments, promoted by a government program (*Programa de Modernización Ganadera*), in milk and meat producers' profit in Region IX. Using a system of simultaneous equations, the effect of the investment on quality, in the price, in the yield and production cost of milk were estimated. In the case of milk, we reject the nonlinear hypothesis that the elasticities of investment in genetic improvement in gross income and variable costs are equal to zero. The estimation was done using information of 276 producers of the IX Region that participated in the program during the period 1998-99 (17,3 % of the regional population), with information for the years 1998 (baseline), 2001 and 2003. The results indicate that the investment in infrastructure had a positive and statistically significant impact in the quality of milk, which translates into a higher price received by producers. Meanwhile the investment in genetic improvement had a positive and significant effect in milk yield, but also in costs. Similar results were obtained for meat production, but the effect is weaker than in milk production, especially for infrastructure investments.

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Introduction

As a result of the signing of free trade agreements by the Chilean government farmers are receiving support through programs that try to improve their competitiveness. Part of this support is directed towards small farmers whose commercial viability is not clear in part due to a lack of human, physical and financial capital and also because of competition from international markets. Two of the main constraints for growth that are subject to short term policy intervention are access to credit and technical assistance. This study looks at the role that financial support, technical assistance as well as education has had on profits of cattle farmer from the IX region in Chile. These farmers are assisted by INDAP, an agency from the Ministry of Agriculture through the program for Investment development, PDI.[3]

Other studies have looked into the effects that several farm sector support programs have had on farmers but most look only into summary information and average changes. Lopez (1996)[4] found that although there was an increase in production and yields in farmers participating in the Technology Transfer Program (PTT),[5] this result is in part due to selection bias. Moreover he found that the increase in production was more than compensated by an increased cost and less out of farm income, having a questionable impact on overall welfare. Similar results were found by Caro et al (2005) when looking at the Incentives for the Recovery of

[3] *Programa de Desarrollo de Inversiones*
[4] Se also Monardes et al., 1993; Banco Mundial, 1994; Berdegué, 2000)
[5] *Programa de Transferencia tecnológica*

Degraded Land Program (SIRSD).[6] This study did consider selection bias in its econometric modeling, and found evidence on yield increases but was not conclusive about the impact on profits.

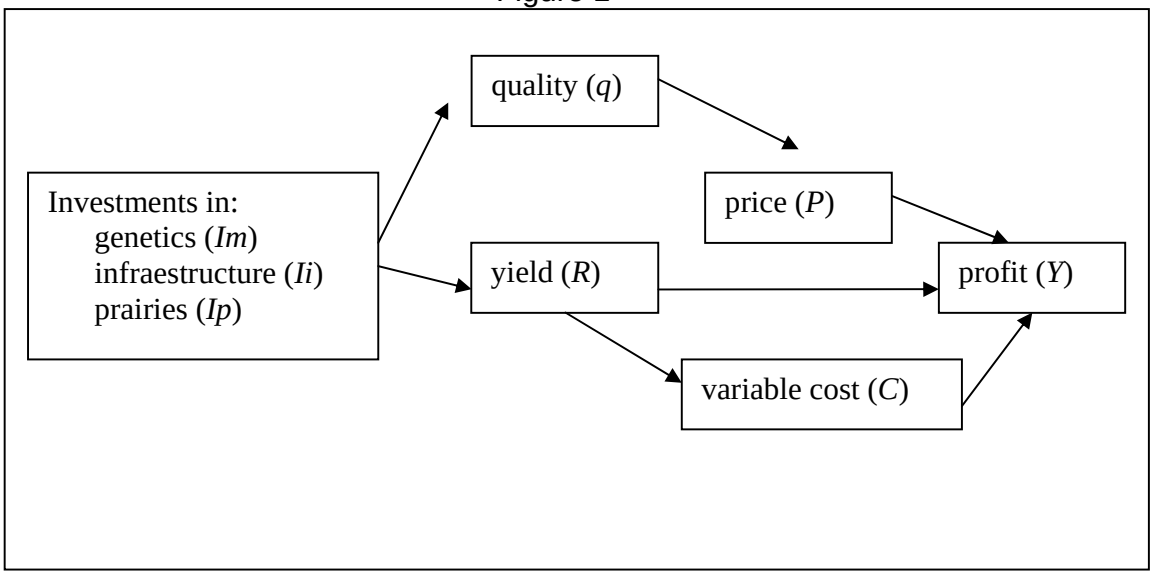
Model and Data

Based on stylized facts of the situation of small farmer in Chile we propose a simple model where profit (*Y)* depends on yields (*R)*, price (*P)*, costs (*C)* and in the case of milk also quality (*q)*.

$$Y = P(q) \cdot R - C \tag{1}$$

We suggest that the impact that investments in livestock genetic quality, infrastructure and prairie quality affect profit directly through a change in yields and costs,[7] and indirectly through a change in quality and thus price, as shown in Figure 1.

Figure 1



[6] *Sistema de Incentivos para la Recuperación de Suelos Degradados.*
[7] We do not consider fixed cost, it may have en impact on medium to long term decision.

From these relationships we derive a system of equation that can explain the impact of investment on each component and therefore on profit.

Price: $P = P(q, Z)$

Yield: $R = R(Ip, Ii, Im, P, Z)$ (2)

Variable Cost: $C = C(R, Z)$

Quality: $q = q(Ip, Ii, Im, Z)$

Where Z represents a set of other factors affecting each variable. This last equation and quality in general will only be considered for milk cattle. In this system then, price, yield, variable cost and quality are endogenous variables.

The data used correspond to the commercial segment of small farmers assisted by INDAP in the IX Region. From a total of approximately 1.900 farmers, 532 participated in the program during the 1998 season, and a sample of 276 were randomly selected for this study. From this number 171 were milk producer and 105 were beef cattle producers. Milk producers delivered to four different plants. Information was available from INDAP for the year 1998 and 2001. Additional data was collected for the year 2003, thus generating a panel for three years.

Model Specification

The panel was used to construct dependant variables of system (2) that reflected their change for the periods 1998-2001 and 1998-2003. Also initial values for

investment and final values for other values were use in each equation. Thus for milk system (2) yields:

Change in Milk Quality

$$\Delta \ln q_i = \alpha_0 + \alpha_1 \ln Ii_{i,t-k} + \alpha_2 \ln \mathrm{Im}_{i,t-k} + \alpha_3 \ln Iap_i + \alpha_4 \ln Ei + \alpha_5 \ln U_i + \alpha_6 \ln S_i + \alpha_7 AT_i + \sum_{j=8}^{10} \alpha_j PP_j + \varepsilon_i$$

Change in Milk Price

$$\Delta \ln P_i^L = \beta_0 + \beta_1 \Delta \ln V_i + \beta_2 \Delta \ln q_i + \sum_{j=3}^{5} \beta_j PP_j + \sum_{j=6}^{9} \beta_l Z_l + \eta_i$$

Change in Milk Yields

$$\Delta \ln R_i^L = \gamma_0 + \gamma_1 \ln Ii_{i,t-k} + \gamma_2 \ln \mathrm{Im}_{i,t-k} + \gamma_3 \ln Iap_i + \gamma_4 \Delta \ln P_i + \gamma_5 \ln E_i + \gamma_6 \ln U_i + \gamma_7 \ln S_i + \gamma_8 AT_i + \sum_{j=9}^{15} \gamma_j Z_j + \mu_i$$

Change in Milk costs

$$\Delta \ln C_i^L = \theta_0 + \theta_1 \Delta \ln R_i + \theta_2 \ln E_i + \theta_3 \ln U_i + \theta_4 \ln S_i + \theta_5 AT_i + \sum_{j=6}^{11} \theta_j Z_j + \upsilon_i \quad .$$

In the case of beef cattle the system of equation in (2) is reduced to two equations one for yield and the other for cost, since there are no quality consideration and the price is not responsive to individual conditions. These equations are:

$$\Delta \ln R_i^C = \lambda_0 + \lambda_1 \ln Ii_{i,t-k} + \lambda_2 \ln \mathrm{Im}_{i,t-k} + \lambda_3 \ln Iap_i + \lambda_4 \ln E_i + \lambda_5 \ln U_i + \lambda_6 \ln S_i + \lambda_7 AT_i + \sum_{j=9}^{15} \lambda_7 Z_8 + \sigma_i$$

for yield, and

$$\Delta \ln C_i^C = \delta_0 + \delta_1 \Delta \ln R_i^C + \delta_2 \ln E_i + \delta_3 \ln U_i + \delta_4 \ln S_i + \delta_5 AT_i + \sum_{j=6}^{11} \delta_j Z_j + \omega_i$$

for cost.

Where:

Δlnq = represents the change in the log of the milk quality measure in CFU (colony forming units)

Ii = infraestructure investment in 1998 (1998 chilean pesos)

Im = genetic improvement investments in 1998 (1998 chilean pesos)

Iap= cumulative prairie investment (1998 chilean pesos)

E = age of farmer (years)

U= schooling (years)

S = proportion of farming area devoted to cattle

AT = received technical assistance (1=yes, 0=no)

PP_j = plants were milk is delivered, dummy variables.

ΔP= change in milk price (1998 chilean pesos per liter)

$\Delta \ln V$= change in the log of milk sales (liters)

Z_l = dummy for *Comunas*

$\Delta \ln R^L$= change in the log of milk yield (liters per hectare)

$\Delta \ln C^L$= change in the log of variable cost in milk production (1998 chilean pesos per hectare)

$\Delta \ln R^C$= change in the log of beef yield (kilos/hectare)

$\Delta \ln C^C$= change in the log of variable costs in beef production (1998 chilean pesos per hectare)

Estimation and Results

The systems of equations were estimated using three stage least squares and for changes in the periods 1998 to 2001 and 1998 to 2003.

The estimated equations for milk are presented on the following four tables.

Table 1

ln(CFU change)	Changes for period 1998-2001			Changes for period 1998-2003		
	Coef.	Std. Err.	Significance	Coef.	Std. Err.	Significance
Investmet in infraestructure	-0.0209764	0.0024977	***	-0.0193992	0.0024529	***
Investment in genetics	-0.0018425	0.0022786		0.000378	0.0021396	
Investment in prairies	0.0221518	0.0463714		0.024291	0.0384333	
Age	-0.0596353	0.1310785		-0.1773625	0.1327225	
Schooling	-0.149554	0.0726809	**	-0.1582734	0.0696656	**
cattle area proportion+	0.0749626	0.1542983		0.0820662	0.1416901	
Technical assitance	-0.1978582	0.0629063	***	-0.1664323	0.0621442	***
Plant 1	0.4448947	0.1661198	***	0.4151999	0.1799945	**
Plant 2	0.1333141	0.1598089		0.1854518	0.1713804	
Plant 3	-0.1674838	0.1561459		-0.1520625	0.1691197	
_cons	-3.207132	0.906192	***	-2.923102	0.839971	***

Note: all continuous variables are in logarithms except when noted with a +.
*** significant at 1%, ** significant at 5%, * significant at 10%.

Table 1 shows that infrastructure investments had a significant and positive effect on milk quality (or a negative effect on CFU) in both periods considered. Schooling and technical assistance also had the same effect in improving milk quality.

Table 2

ln(yield change)	Changes for period 1998-2001			Changes for period 1998-2003		
	Coef.	Std. Err.	Significance	Coef.	Std. Err.	Significance
Investmet in infraestructure	0.0018003	0.0022351		0.0027575	0.0022836	
Investment in genetics	0.018291	0.0022219	***	0.0091539	0.0021445	***
Investment in prairies	-0.0305616	0.0431952		-0.1020263	0.037274	***
Age	0.319841	0.124457	**	0.2122296	0.1299272	
Schooling	0.2301097	0.0696346	***	0.1886607	0.0682004	***
cattle area proportion+	0.2194896	0.1500943		0.1424148	0.1390953	
Technical assitance	-0.0425691	0.0590087		-0.026741	0.0603598	
Z_renaico	0.0344516	0.1446192		-0.0719584	0.1617542	
Z_curacaut	0.1005699	0.1637733		0.1693501	0.1688131	
Z_vilcun	-0.0449731	0.1411014		0.0627763	0.1562933	
Z_pitruf	0.0404042	0.1408897		0.1121618	0.156319	
Z_freire	0.1175287	0.162686		0.2542094	0.1730714	
Z_gorbea	0.0588291	0.1497299		0.0590978	0.1625495	
Z_villarri	-0.0454804	0.1657893		-0.0021879	0.1783313	
_cons	-1.08064	0.8506782		2.010738	0.8088958	**

Note: all continuous variables are in logarithms except when noted with a +.
*** significant at 1%, ** significant at 5%, * significant at 10%

Table 2 shows that investment in genetic improvements and schooling had a positive and significant impact on increasing yield. Age on the other hand only had a significant impact during the first period which was positive. Investment in prairies had a negative impact on yield change, a result that is not expected.

Table 3

ln(price change)	Changes for period 1998-2001			Changes for period 1998-2003		
	Coef.	Std. Err.	Significance	Coef.	Std. Err.	Significance
sales	0.0210642	0.0091659	**	0.0168911	0.0078192	**
ln(change in CFU)	-0.0847349	0.0126745	***	-0.0795819	0.0118974	***
Z_renaico	0.0173545	0.0211959		0.0197015	0.0218374	
Z_curacaut	-0.019619	0.0160338		-0.0148089	0.0135617	
Z_pitruf	0.0286692	0.0148673	*	0.035001	0.0128809	***
Z_gorbea	0.0362918	0.0163417	**	0.0407931	0.0142533	***
Z_villarri	0.0817277	0.0195282	***	0.0892669	0.0174728	***
Plant 2	-0.0101935	0.0208802		0.0004951	0.0211549	
Plant 3	-0.0724244	0.0239875	***	-0.0660088	0.0230761	***
_cons	-0.2201749	0.0996797	**	-0.1898488	0.0952135	**

Note: all continuous variables are in logarithms except when noted with a +.
*** significant at 1%, ** significant at 5%, * significant at 10%

Table 3 shows that the volume of sales and the change milk quality increased price change in both periods. It can also be noted that farmers in different *Comunas* and delivering to different plants had significantly different milk price changes.

Table 4

ln(cost change)	Changes for period 1998-2001			Changes for period 1998-2003		
	Coef.	Std. Err.	Significance	Coef.	Std. Err.	Significance
ln(change in yield)	4.764949	1.938773	**	11.856	1.533383	***
number milking cows+	0.0460336	0.0260834	*	-0.0558081	0.0107335	***
Investmet in infraestructure	-0.0144127	0.0076582	*	-0.0355739	0.0142622	**
Investment in genetics	-0.0725305	0.0361262	**	-0.0878162	0.0188752	***
Investment in prairies	-0.1904544	0.1314665		1.053164	0.2760352	***
cattle area proportion+	-0.6179202	0.4892339		-1.403332	0.8610764	
Age	-1.584865	0.8265558	*	-2.342172	0.8306347	***
Schooling	-1.291212	0.5443989	**	-2.244139	0.4936748	***
Technical assitance	0.1724234	0.1672426		0.2316117	0.3628683	
Z_renaico	-0.0801107	0.4070104		0.8770616	0.9701614	
Z_curacaut	-0.0398072	0.4825533		-1.490108	1.033937	
Z_vilcun	-0.0156344	0.395912		-0.8151006	0.9378201	
Z_pitruf	-0.2812246	0.4424338		-1.209975	0.9468875	
Z_freire	-0.8011711	0.5558939		-3.194511	1.116101	***
Z_gorbea	-0.1568062	0.4470584		-0.55269	0.9721287	
Z_villarri	0.4273547	0.4748188		0.4533346	1.063603	
_cons	10.08189	4.381251		-21.83569	5.83727	***

Note: all continuous variables are in logarithms except when noted with a +.
*** significant at 1%, ** significant at 5%, * significant at 10%

Table 4 shows the results for the cost equations. As expected costs increased with yield increases in both periods. The number of milking cows owned by the farmer seems to have evolve from having marginally significant and positive impact in cost changes to one with definite reduction in cost per hectare. It also seems that investments impact on cost become more definite in the second period. With infrastructure and genetic investment having a negative effect on cost change, but prairie investment having a positive effect on cost change in the second period.

In the case of beef production the system of equations estimates are presented in Tables 5 and 6. As it can be seen in Table 5 both investment in infrastructure and in genetics have a positive and significant effect on change in yield for both periods. In this case it appears that this result is slightly more robust for the first period.

Table 5

ln(yield change)	Changes for period 1998-2001			Changes for period 1998-2003		
	Coef.	Std. Err.	Significance	Coef.	Std. Err.	Significance
Investmet in infraestructure	0.1153316	0.0550402	**	0.1044227	0.0552948	*
Investment in genetics	0.1044227	0.0552948	***	0.1153316	0.0550402	**
Investment in prairies	0.0434435	0.0587717		0.0434435	0.0587717	
Age	0.0262399	0.2024636		0.0262399	0.2024636	
Schooling	-0.0375492	0.0876659		-0.0375492	0.0876659	
cattle area proportion+	-0.0162419	0.1825426		-0.0162419	0.1825426	
Technical assitance	0.0246137	0.0729121		0.0246137	0.0729121	
Z_curacaut	-0.0332048	0.3399516		-0.2415507	0.3040224	
Z_renaico	-0.2415507	0.3040224		-0.0332048	0.3399516	
Z_vilcun	-0.2348373	0.3038805		-0.2348373	0.3038805	
Z_pitruf	-0.2408898	0.3117954		-0.2408898	0.3117954	
Z_gorbea	-0.1665289	0.3038788		-0.1665289	0.3038788	
Z_villarri	-0.1243266	0.3422409		-0.1243266	0.3422409	
_cons	0.1516327	1.082516		0.1516327	1.082516	

The impact in cost change can be seen in Table 6, where is clear that an increase in yield will bring along a increase in change on cost. Note also that apparently increasing production will reduce per hectare variable costs of production.

Table 6

ln(cost change)	Changes for period 1998-2001			Changes for period 1998-2003		
	Coef.	Std. Err.	Significance	Coef.	Std. Err.	Significance
ln(change in yield)	0.774121	0.0819857	***	0.774121	0.0819857	***
meat cattle production	-0.2907667	0.0997715	***	-0.2907667	0.0997715	***
cattle area proportion+	-0.2338199	0.1966764		-0.2338199	0.1966764	
Investment in genetics	-0.0326513	0.0595737		-0.0326513	0.0595737	
Investmet in infraestructure	-0.0327077	0.0597495		-0.0327077	0.0597495	
Age	0.0458167	0.0702637		0.0458167	0.0702637	
Schooling	-0.0091722	0.213104		-0.0091722	0.213104	
Technical assitance	-0.0230084	0.0925662		-0.0230084	0.0925662	
Z_renaico	0.0679154	0.0795654		0.0679154	0.0795654	
Z_curacaut	-0.3803015	0.3575443		-0.3803015	0.3575443	
Z_vilcun	-0.170744	0.3206708		-0.170744	0.3206708	
Z_pitruf	-0.0872631	0.3218788		-0.0872631	0.3218788	
Z_freire	-0.2849429	0.3286596		-0.2849429	0.3286596	
Z_gorbea	-0.2610172	0.3198146		-0.2610172	0.3198146	
Z_villarri	-0.137118	0.3601836		-0.137118	0.3601836	
_cons	2.108162	1.343158		2.108162	1.343158	

Conclusions

The main conclusion that can be derived from this study is that the program did have the expected impact, *i.e.* increasing yields and in the case of milk also increasing profits. It should be noted though that investment in prairies did not have in desirable effect on production and profits.

It appear that education does play a role in the improvements in milk quality, yield and cost. There also seem to be some economies of scale in meat cattle and also in milk but in the longer period.

This program that subsidizes half of the investments done by the farmer appears to a have definite on profit improvement at leas for some of the items of investment and for milk production. Future research should consider the question if this subsidies are really necessary and if there exist a potential bias in the participation in the program. Something that could not be explored here due to data limitations.

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