

PUBLIC INSTRUMENTS FOR BUSINESS MANAGEMENT IN CHILEAN WINE INDUSTRY: A COMPARATIVE ANALYSIS OF DISCRETE CHOICE MODELS

INSTRUMENTOS PÚBLICOS DE GESTÃO DE NEGÓCIOS NA INDÚSTRIA VINÍCOLA CHILENA: UMA ANÁLISE COMPARATIVA DE MODELOS DE ESCOLHA DISCRETA

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SUMMARY

In Chile there is a wide availability of public instruments to promote productivity in business management, which in practice serve as financial hedge instruments. Based on multivariate analysis the authors estimate the probability of using public instruments in Chilean wine industry comparing logit and probit models. Results indicate that probability depends on different socioeconomic variables and sources of risk. The global correct prediction was estimated in 80.5% through ROC curve analysis.

RESUMO

No Chile, existe uma ampla disponibilidade de instrumentos públicos para promover a produtividade na gestão dos negócios, que na prática funcionam como instrumentos de *hedge* financeiros. Com base em análise multivariada, os autores estimam a probabilidade de utilização de instrumentos públicos na indústria vinícola chilena, comparando a avaliação de modelos logit e probit. Os resultados indicam que a probabilidade depende de diversas variáveis socio-econômicas e das fontes de risco. A previsão global correta foi estimada em 80,5%, através de análise da curva ROC.

Key words: financial hedge instruments, multivariate analysis, sources of risk, ROC curve.

Palavras-chave: Instrumentos *hedge* financeiros, análise multivariada, fontes de risco, curva ROC.

INTRODUCTION

In Chile there is a wide variety of public instruments to promote productivity in business management, especially in risk management and innovation. In practice, they play a role as financial hedge instruments, such as insurances, futures and derivatives. The effectiveness of these instruments, in terms of the impact on company's investments returns, entrepreneurship and creation of new business, job generation, or the impact on the economy's GDP (Gross Domestic Product), is still a topic in discussion. From a risk management point of view, empirical evidence shows that the majority of farmers are risk-averse (Binswanger, 1981; Antle, 1987; Bardsley & Harris, 1987; Binswanger & Deininger, 1997; Anderson & Hardaker, 2003) when facing economic or production decisions.

Different to other markets, incomplete markets are observed in the agricultural sector due to the relative shortage of uncertainty and risk management instruments, such as insurances, loans, futures and

derivates. According to Skees and Barnett (1999), as risk coverage is clearly less than the social optimum, an economic efficiency loss is incurred. The poor development of financial coverage instruments is usually used as an argument to justify government intervention in agriculture. For example, extraordinary aids are required in emergency situations that emerge in agricultural economic crisis (Díaz-Caneja, 2004), which originates an inevitable economic policy where the optimum is the establishment of *ex ante* government policies instead of this more expensive *ex post* aid (Innes, 2003). On the other hand, Meuwissen *et al.* (1999) justify government intervention through risk reduction public instruments or through "aids" when risk has more systemic characteristics.

Anderson (2003) argues that farmers are exposed to many risks, and there is often a lack of instruments to manage them correctly. The solution to this problem implies many strategies (prevention, mitigation, adaptation) and dispositions (informal, market based, public) to face risk, and the instruments have to con-

sider the sources and characteristics of agricultural risk. Innes (2003) and Hardaker *et al.* (2004) suggest considering first “auto selection” as a mechanism to manage risk, which is conceived as the farmers’ acceptance of real or subjective risks. Innes (2003) concluded that aids or *ex ante* compensations contribute better to select those producers who assume risk and improve efficiency of public spending, in comparison to those that guarantee a generalized support once the event has occurred. “Auto selection” is a useful filter to select farmers with the right of being supported by the government in developed economies, avoiding the excessive risks of those who are drawn from being recipients of such support (ENESA, 2004).

The multivariate analysis techniques (McFadden, 1974; Altman *et al.*, 1981; Jobson, 1992) are widely used among diverse disciplines such as financial economy, biotechnology, environment, agronomy, chemistry and software engineering. In financial economy, research is focused in predicting the probability of bankruptcy in financial markets (Johnsen and Melicher, 1994; Lennox, 1999; Westgaard and Wijst, 2001; Grunert *et al.*, 2005; Bandyopadhyay, 2006; Chi and Tang, 2006). In the wine industry, discrete choice models are centered in consumers’ preferences and purchase choice (Morey *et al.*, 2002; Skuras and Vakrou, 2002; Ho and Gallagher, 2005; Rodríguez *et al.*, 2009). Using a sample of 104 wineries and restrained to logit models, Lobos and Viviani (2008) and Lobos (2009) propose a model to predict the probability to use public instruments in Chilean wine industry.

This research is an extension of previous works and its contribution lies in the generation of logit and probit models comparing the Chilean wine producers willingness to use these public instruments for a smaller sample. The main objective of this study is to identify the variables that influence the probability to use public instruments in Chilean wine industry, through comparative analysis of logit and probit models.

MATERIALS AND METHODS

The sample

The data used in this research was compiled between January and October of 2007 through the application of a questionnaire about risk sources in Chilean wine industry (see Lobos, 2009). The questionnaire has seven sections and was applied in companies located in most of the wine producing valleys of Chile. Each measurable variable was captured through indicators, which were measured using Likert type scales of five and seven points. In other cases open and closed questions were used (dichotomic and multiple options), and interval and nominal scales. In this investigation a sample of 84 wineries was used, smaller than the one used in Lobos and Viviani (2008) and Lobos

(2008) works. Wineries not included in *Chilean Wine Industry Directory* (CCV, 2010), were eliminated from the original sample. The data was processed using EViews 6 and SPSS 15.

Dependent and explanatory variables

With the objective of contrasting the influence of the principal explanatory variables over the decision of using public instruments, the models binomial logit and probit were considered, in which the use of public instruments was introduced as dependent variable, and various socioeconomic variables and sources of risk were introduced as explanatory variables (see Table I).

The model

The logit and probit models are usually estimated by the method of maximum likelihood (Greene, 1999; Wooldridge, 2006) originally proposed by Fisher (1922) as a classical estimation method of the parameters associated with density functions or random variables probability. Let Y_i be defined as a random variable with probability function $f(y; \beta)$ where β is an unknown parameter. In a binary choice model Y_i takes only two values: 1 if there is success and 0 otherwise. We are interested in the response probability (Lobos *et al.*, 2010):

$$P(y = 1|x) = G(\beta_0 + \beta_1 x_1 + \dots + \beta_k x_k) = G(\beta'x), \quad (1)$$

In expression (1), X is a vector of explicative variables and β' is a vector of parameters which includes the intercept. Function G takes only values between zero and one $0 < G(z) < 1$, where Z is a real number obtained from $z = \beta'x = \beta_0 + \beta_1 x_1 + \dots + \beta_k x_k$. In the logit model function G is the cumulative distribution function (CDF) of the standard logistics:

$$G(z) = \frac{\exp(z)}{1 + \exp(z)} = \frac{1}{1 + \exp(-z)} = \frac{1}{1 + \exp(-\beta'x)} \equiv \Lambda(z) \equiv \Lambda(\beta'x), \quad (2)$$

In the probit model, function G is the cumulative distribution function (CDF) of a normal random variable:

$$G(z) = \int_{-\infty}^z (2\pi)^{-1/2} \exp(-z^2/2) dz \equiv \Phi(z) \equiv \Phi(\beta'x) \quad (3)$$

To evaluate the goodness-of-fit of the models different statistical tests were used: McFadden’s R^2 (McFadden, 1973), Pearson’s chi-square (Hosmer and Lemeshow, 1980), Akaike’s Information Criterion, AIC (Akaike, 1974), Bayesian Information Criterion, BIC, or Schwarz Criterion (Schwarz, 1978), Hannan-Quinn Criterion, HQC (Hannan and Quinn, 1979), Likelihood Ratio (LR), -2 Logarithm of the Likelihood (-2LL), Cox & Snell R^2 and Nagelkerke’s (1991) adjusted R^2 .

TABLE I

Definition of the dependent and independent variables in the logit and probit models

Definição das variáveis dependentes e independentes nos modelos logit e probit

Dependent variable	
UIP	Use of public instruments: «0» means that the wine-growing company doesn't use public instruments for risk management, «1» means it does
Independent variables	
DCSI	Long term contracts availability (one year or more): «0» if the firm does not have long term contracts, «1» if it has
NIPC	Number of public instruments known by the firm, not necessarily used (continue)
CFDC	Weather derivatives knowledge: «0» if it is not known, «1» if it is known
PPPR	Percentage of ownership of the company (binary): «1» if the respondent participation in the company's capital is greater than 50%, «0» if it is less
DAEX	External advice availability: «0» if the firm does not have external advice, «1» if it has
NTPE	Number of permanent employees in the firm (binary): «0» if it has less than 20 employees, «1» if it has 20 or more
USGR	Use of insurance contracts: «0» means that the wine-growing company doesn't use insurance contracts for risk management, «1» means it does
IBOL	Stock exchange investment: «0» if the firm does not have realized inversions during the past five years, «1» if it has
AIMV	Wine market access: «1» if the access to wine market information is easy, «0» if it is difficult

It is possible to evaluate the global predictive power of the logit and probit models using Receiver Operating Characteristic (ROC) curve analysis (Lloyd, 1998; Cai and Pepe, 2002; Zhou and Castelluccio, 2003). The area under the ROC curve can then be interpreted as the probability that in the presence of a couple of observed cases like 1 and 0 the test would classify them correctly (Hanley and McNeil, 1982).

Characteristics of the companies in the sample

The sample includes wineries located in the main wine producing valleys of Chile: Aconcagua, Maipo, Rapel, Curicó and Maule. In 32 companies there were less than 12 permanent workers and in 52 there were more than 12 workers. 51 companies showed sales for less than US\$ 1 million and 29 declared sales for more than US\$ 1 million. 21% of the small wineries have used public programs or instruments of development, while on the other hand 79% of the large wineries have used them (see Table II).

In this research companies were grouped in small and large wineries: less than 50 ha and more than 50 ha, according Servicio Agrícola y Ganadero's classification of a vineyard considering surface planted with grape vines (SAG, 2007). In addition wineries were grouped according sales level (less or more than US \$1 million) and number of permanent workers (less or more than 12 workers). To measure linear relation between surface planted and sales level, and surface planted and number of permanent workers,

Spearman's rho correlation coefficient was applied. Considering that a significative correlation was observed ($p < 0.01$) then three criteria of classification might be considered to be substitutes.

RESULTS

Significant variables were long term contracts availability (DCSI) and the number of public instruments known by the firm (NIPC), weather derivatives knowledge (CFDC), Percentage of ownership of the company (PPPR), external advice availability (DAEX) and number of permanent employees in the firm (NTPE). Use of insurance contracts for risk management (USGR), stock exchange investment (IBOL) and access to wine market information (AIMV) turned out to be not significant variables.

The estimated parameters and the results of z-statistic of all the variables included in the models generated are shown in Table III. The sign on DCSI is positive and significant at the 1% level. This result suggests that winegrowers are more willing to use public instruments when the vineyard has long term contracts availability. The sign on NIPC is positive and significant at the 1% level, which indicates that winegrowers perceive more the need of using public instruments when the number of known instruments is higher. The sign on CFDC is negative and significant

at the 5% level, suggesting that if winegrowers think to have weather derivatives knowledge, they will be less willing to use public instruments. The sign on PPPR is positive and significant at the 5% level, indicating that if winegrower's ownership is higher to 50%, they are more willing to use these instruments. The sign on DAEX is positive and significant at the 5% level, implying that winegrowers are more willing to use public instruments when the company has access to external advice. Finally, the sign on NTPE is positive and significant at the 5% level, indicating that if the number of permanent employees is more than 20, then winegrowers are more willing to use public instruments.

The sign on USGR is negative in logit and probit models. This result, even though it is not statistically significant, indicates that winegrowers are less willing to use public instruments when the company is using insurance contracts. The positive sign on IBOL indicates an increase in the probability of using public instruments if the company has made investments in stock exchange markets during the past five years. Lastly, the positive sign on AIMV suggests that if winegrowers perceive that the access to wine market information is easy, then the probability of using

public instruments would increase.

The highest pseudo McFadden's R^2 and the lowest values of the AIC, BIC, HQC criteria suggest that the probit model is more suitable than the logit model to explain the willingness to use public instruments to promote productivity in the Chilean wine industry. The LR and -2LL statistics indicate that the logit and probit estimations are statistically significant to the value $p < 0.001$. The value chi-square calculated is not significant for Pearson's chi-square test and Hosmer-Lemeshow (HL) for the logit and probit models, indicates that the fit of both models is adequate to predict values that are not significantly different from the observed values. Finally, the values in Cox & Snell R^2 and adjusted R^2 Nagelkerke indicate that in the logit model an important percentage of the variance is explained by the variables of the model (see Table IV).

The results shown in Table V indicate that the comparison of the forecasted results with the data observed through a classification table implies that the global correct prediction is 84.31% for logit and probit models. On the other hand, the sensitivity (82.76%) is lower than the specificity (86.36%) for

TABLE II

Characteristics of the wine-growing companies included in the sample

Características das empresas vitícolas incluídas na amostra

Location of the wine-growing companies:	Nbr.^a	%^b
Valley of Aconcagua	7	8.4
Valley of Maipo	11	13.3
Valley of Rapel	11	13.3
Valley of Curicó	9	10.8
Valley of Maule	45	54.2
Number of permanent workers:	Nbr.^a	%^b
Nbr. of companies with less than 12 workers	32	38.1
Nbr. of companies with more than 12 workers	52	61.9
Total:	84	100.0
Surface planted with grape vines:	Nbr.^a	%^b
Nbr. of companies with less than 50 ha	15	19.7
Nbr. of companies with more than 50 ha	61	80.3
Total:	76	100.0
Sales level:	Nbr.	%^b
Nbr. of companies with less than US \$1 million	51	63.8
Nbr. of companies with more than US \$1 million	29	36.2
Number of companies that use public instruments:	Nbr.	%^c
Small wineries	14	20.6
Large wineries	54	79.4
Total:	68	100.0

^aThe total doesn't necessarily correspond to the size of the sample (84 companies).

^bThe values in % correspond to the valid percentages.

^cIs the valid percentage related to the total number of companies in each size.

TABLE III

Results of the multiple regression models estimated via Maximum Likelihood (ML)
Resultados dos modelos de regressão múltipla estimados pelo método "Maximun Likelihood" (ML)

Regressors	Logit	Probit
Constant	-6.423406** (-2.525573)	-3.808340*** (-2.661307)
DCS1	3.895916** (2.565030)	2.321162*** (2.709686)
NIPC	1.008000** (2.497030)	0.603424** (2.551733)
CFDC	-2.274236* (-1.943957)	-1.353862** (-2.116103)
PPPR	3.376359* (1.943794)	2.010357** (2.013058)
DAEX	2.113078* (1.677427)	1.232749* (1.681827)
NTPE	1.767191* (1.650977)	1.059592* (1.724786)
USGR	-0.800672 (-0.693061)	-0.416006 (-0.648710)
IBOL	1.511690 (1.517864)	0.925938 (1.623617)
AIMV	1.575125 (0.998011)	0.891128 (0.984309)

Data computed from the survey. z-statistic in brackets. The dependent variable is the binary variable UIP. *p<0.05, **p<0.01, ***p<0.001. Variables explained in Table I.

the cut-point of 0.50. The area under the ROC curve suggests that there is a probability of 84.60% that considering two companies, one using public instruments and the other not, the test will classify them correctly. Fig. 1 shows the ROC curve for the logit and probit models estimated.

DISCUSSION

The main contribution of this study is to facilitate business management in the wine industry, through an empirical investigation that allows to model Chilean vineyard growers behavior respect to the use of public instruments to promote productivity. The study is necessarily exploratory, as like most exploratory studies the results are based on a sub-optimal sample. The sample used here is small (N=84) but fairly homogeneous in terms of characteristics such as production processes, location and markets for the wine.

This investigation has also shown the usefulness of discrete choice models (logit and probit) in identifying the individual characteristics that influence the probability of using public instruments in the winegrowing industry management. The analysis allows inferring about the influence of a set of socioeconomic variables and the winegrowers' own perceptions have on the willingness to use public instruments. As it is suggested in the literature (Amemiya, 1981; Maddala, 1996) the coefficients of probit model are related to approximately 0.6 of the logit estimators.

In general, the sign of the coefficients confirm the pre-

vious perception about the factors that positively influence on the probability of using public instruments. This is, there is more willingness to use these instruments when wineries have long term contracts with their clients (one year or more), when the number of public instruments known by the firm is higher, when the percentage of ownership of the winegrower is more than 50%, when the firm has access to external advice and when there are more than 12 permanent employees in the firm. The relations described seem to agree with previous perception and economic theory. The existence of contracts with longer durations decreases risk and the uncertainty over future cash flows, allowing increasing the willingness to use public instruments to improve management in middle term. In the case of the number of instruments known by the firm, the better the perception about their utility, the greater the disposition to use them. The positive relation between the willingness to use public instruments and the winegrower's ownership of the firm could be reflecting an Agency Problem, or a conflict of interest arising between shareholders and managements because of differing goals. The access to external advice allows decision makers to be more informed about the variety and availability of these instruments for business management, contributing positively to the use of them. Finally, wineries with more than 12 permanent employees are the biggest ones, and have more access to information and public and private nets, which impacts positively a conjoint formulation and postulation to some instruments specially those related to technological visits, access to

TABLE IV

Goodness-of-fit evaluation of the models estimated via Maximum Likelihood (ML)
Avaliação do ajustamento dos modelos estimados pelo método "Maximum Likelihood" (ML)

Estatistic	Logit	Probit
McFadden's R^2	0.511023	0.518269
Akaike's Information Criterion (AIC)	1.068330	1.058310
Bayesian Information Criterion (BIC) or Schwarz Criterion	1.447119	1.437100
Hannan-Quinn Criterion (HQC)	1.213076	1.203057
Likelihood Ratio statistic (LR) – Omnibus tests	36.03962***	36.55061***
-2 Logarithm of the Likelihood (-2LL)	34.485***	.
Pearson's chi-square test	31.197 Prob(Pearson): 0.866	30.501 Prob(Pearson): 0.885
Hosmer-Lemeshow (HL) chi-square statistic	7.6408 Prob(HL): 0.4693	8.0887 Prob(HL): 0.4249
Cox & Snell R^2	0.507	.
Nagelkerke Adjusted R^2	0.676	.
Data computed from the survey. ***p<0.001		

international wine fairs, experts visits and assistance to international congresses.

The knowledge of weather derivatives functioning influences negatively on the probability of using public instruments. This could be explained because weather derivatives are relatively new instruments for financial coverage, and those who normally know them are decision makers from wineries that have a business management more oriented to market instruments, and usually participate in insurance contracts and forward transactions. The variables use of insurances

for risk management (USGR), stock exchange investment (IBOL) and access to wine market information (AIMV) turn out to be not significant in the models.

The results of the goodness-of-fit indicate that in all the evaluated models of regression a good global fit is achieved, with a preference towards the probit over the logit model. Nevertheless, both the indicators of the classification table and the area under the ROC curve allow to deduce that the global predicting power of the logit and probit models is high.

TABLE V

Expectation-Prediction evaluation for binary specification of the models estimated via Maximum Likelihood (ML) method
Avaliação do expectativa-previsão para especificações binárias pelo método "Maximum Likelihood" (ML)

Observed cases	Estimated equation for probit and logit models			% Correct
	UIP=0	UIP=1	Total	
UIP=0	19	5	24	79.16
UIP=1	3	24	27	88.89
Total	22	29	51	.
Correct	19	24	43	.
% Correct	86.36	82.76	.	84.31
% Incorrect	13.64 [†]	17.24 ^{††}	.	15.69
% Total	100.00	100.00	.	.
% Area under the ROC curve		84.60		

Data computed from the survey. The dependent variable is the binary variable UseIC. † and †† are type I and type II errors, respectively.

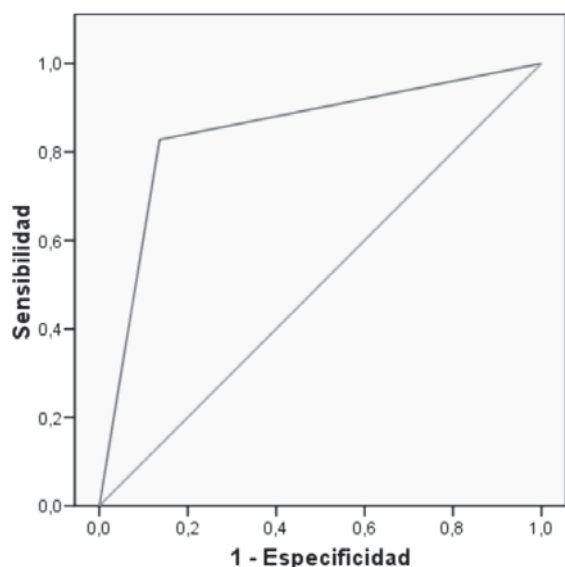


Figure 1. ROC curve for binary specification of the models estimated via Maximum Likelihood (ML) method.
Curva ROC para especificação binária dos modelos estimados pelo método "Maximum Likelihood" (ML)

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