

PREDICTING PROBABILITY TO PURCHASE INSURANCE CONTRACTS IN THE CHILEAN WINE INDUSTRY: A LOGIT AND PROBIT COMPARATIVE ANALYSIS

PROBABILIDADE DE PREDIÇÃO PARA COMPRAR CONTRATOS DE SEGURO NA INDÚSTRIA DE VINHO CHILENA: UMA ANÁLISE COMPARATIVA LOGIT E PROBIT

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SUMMARY

In the less developed countries the use of market instruments for risk management is still limited. The main purpose of this study is to identify the variables that have an influence on the probability of using insurance contracts in the wine industry of Chile. Binomial logit and probit models were applied using a sample of 84 firms. Our results indicate that the probability of purchasing insurance depend on wine market access and insurance contracts risk management ($p < 0.01$), total surface planted with vineyards, wine prices access, sanitary risk and expected hedging insurance contracts ($p < 0.05$). The global correct prediction was estimated (83.33%) using Receiver Operating Characteristic (ROC) curve analysis. One important conclusion is that viticulturists are more willing to buy insurance contracts if they perceive that these will allow an adequate management of risk.

RESUMO

Nos países menos desenvolvidos o uso de instrumentos de mercado para a gestão de risco é ainda escasso. O objectivo principal desta investigação é identificar as variáveis que influenciam sobre a probabilidade de utilização de contratos de seguros na indústria de vinho chilena. Aplicaram-se modelos logit e probit usando uma amostra de 84 empresas. Os nossos resultados indicam que a probabilidade de adquirir seguros depende do acesso a mercados para o vinho ($p < 0,01$), da superfície total plantada com vinhedos, acesso a preços do vinho, riscos sanitários e a cobertura esperada dos contratos de seguros ($p < 0,05$). A predição global do modelo (83,33%) foi estimada usando a análise da curva Receiver Operating Characteristic (ROC). Uma importante conclusão é a de que os viticultores estão dispostos a contratar seguros se perceberem que tais contratos permitem gerir adequadamente o risco.

Additional key words: binomial model, wine market access, risk management, ROC curve

Palavras-chave: modelo binomial, acessos a mercados para o vinho, gestão de risco, curva ROC.

INTRODUCTION

In the last years the discussion about the availability of market instruments for risk management in agriculture has intensified. One central aspect of the discussion is the design of financial coverage instruments for the management of risk reduction, which is expressed basically in the high volatility of the principal risks that agricultural producers face. A recent study by Lobos and Viviani (2010) indicates that for Chilean viticulturists the main risks sources are the exchange rate, wine price, climatic changes, yields and sanitary risks. Even though the Chilean market of risk management instruments is still in-

ipient, there exist some instruments available, as agricultural insurance policy and forward contracts (interest rates and exchange rate). This limited development is made worse by the fact that this is a sector in which there exist information asymmetries (i.e., moral hazard and adverse selection).

One relevant characteristic in the provision of goods and public services is the existence of incomplete markets, which has negative effects on the economic efficiency. In the agricultural private markets it is possible to find this market failure, in terms of the relative shortage of instruments to face risk and uncertainty. According to Skees and Barnett (1999),

as the level of covered risks is clearly less than the socially optimal amount, there is necessarily a loss of efficiency in the allocation of resources.

The limited development of the main financial coverage instruments, such as insurance contracts, loans, futures and derivatives, is usually used as an argument to justify a greater intervention of the government in agriculture. According to Meuwissen *et al.* (1999), as the government has an influence on the farmers' decisions through the legal frame, it becomes a co-responsible for the potential losses, so justifying its participation with public instruments of risk reduction or through "aids" when the risk has more systemic characteristics.

Different authors (Hardaker *et al.*, 2004; Meuwissen *et al.*, 1999; Just and Pope, 2002) suggest that the types of insurances usually available in agriculture are insurances on expected yields, insurances on prices, revenue insurance, net income insurance, insurances against catastrophic losses and basic coverage against income crisis. In general, for the correlated agricultural risks are more adequate the latest instruments for the management of risk, such as forward, futures and derivatives (Carpenter, 2005), while on the other hand, for the less correlated risks the more traditional instruments are applicable (Meuwissen *et al.*, 1999).

The bivariate and multivariate analysis techniques, such as logit, probit and tobit (Tobin, 1958), are widely used in diverse disciplines of scientific research such as psychology, economics and finance, politics, law, environment, biology, biotechnology, agriculture, chemistry, health, software engineering and education. In finances the literature is concentrated in predicting the probability of business failure in different financial markets (Johnsen and Melicher, 1994; Lennox, 1999; Westgaard and Wijst, 2001; Grunert *et al.*, 2005; Bandyopadhyay, 2006; Chi and Tang, 2006). In some more specific sectors the logit, probit and/or tobit models have been used to predict the probability of getting health insurance or life insurance (Hopkins and Kidd, 1996; Sapelli and Torche, 2001; Barrett and Conlon, 2003), to predict the buying decisions in a market (Goldberg, 1995; Banerjee, 2004) or to predict the probability of success of a new product (Kandemir *et al.*, 2006), to predict the selection of urban transportation means (Amador *et al.*, 2005), to assess the impact of human and financial capital on small businesses profitability (Coleman, 2007), and to predict decisions related to the labor market (Aituvh and Kimhi, 2006; Benjamin and Kimhi, 2006).

The studies related with the probability of getting health insurance or life insurance (Nielsen and Mayer, 2000; Tan *et al.*, 2009) suggest that the income of the person or households is statistically significant and influences positively on the probability of getting these insurances. In other words, higher-income consumers were more likely to purchase life insurance policy. In the case of acquisition of non-life insurers Meador

et al. (1986) concluded that the variable having the most significant relationship to the probability of acquisition in the negative value of the return on total investment.

Relatively little research has been conducted that specifically investigates the demand for crop insurance in the context of a revenue insurance program (Mishra and Goodwin, 2003; Goodwin *et al.*, 2004; Sherrick *et al.*, 2004; Shaik *et al.*, 2008). The literature review shows that the demand for crop insurance is inelastic (Goodwin *et al.*, 2004), but the elasticity for choices between yield and revenue insurance is found to be relatively more elastic (Shaik *et al.*, 2008).

In the case of decision-making in agriculture in their works of Shaik *et al.* (2008) indicates that the variables that influence more significantly the probability of acquiring of insurance are the expected return to insurance (sign is positive), average expected price (sign is negative), acreage under irrigation (sign is positive). In other studies it is suggested that the statistically significant variables are the producer's experience and the relative production of the farmer versus the production of the whole industry (Huber, 2005), the amount of farm-related debt, education level, and a history of receiving emergency disaster relief payments (Smith and Baquet, 1996), upon expected premiums to insurance and the variance of returns (Knox and Richards, 1999). The studies suggested that producer's risk aversion is not statistically significant (Chambers and Quiggen, 2002; Shaik *et al.*, 2008).

More specifically in a case of the wine industry econometric applications have been developed to detect problems of information symmetry in the prices of fine wines (Thode *et al.*, 2002), analysis of the "placebo effect of wine" (Priilaid, 2006), and models to explain the hedonic prices of *vitis finifera* and wine based on certain attributes of grapes (Golan and Shalit, 1993) or of the wine (Angulo *et al.*, 2000; van Rensburg, 2004; Priilaid and van Rensburg, 2006; Troncoso and Aguirre, 2006). The models of discrete selection applied to the wine industry are basically circumscribed to the preferences and wine buying decisions of consumers (Morey *et al.*, 2002; Skuras and Vakrou, 2002; Ho and Gallagher, 2005; Rodríguez *et al.*, 2009). Finally, Lobos and Viviani (2008) developed a model of insurance contract in the Chilean wine industry, but restricted to the logit modeling for a sample of 104 enterprises.

This investigation is an extension of the previous work and its contribution lies in the comparison of discrete selection models (logit and probit) applied to the Chilean wine industry and the willingness of the producers to get instruments (insurance) of financial coverage. The methodology used consist in relating binary categorical variables considering one in particular as dependent on the others, through regression functions of its logarithms (McFadden, 1974; Altman *et al.*, 1981; Jobson, 1992). The main

purpose of this research is to identify the variables that have an influence on the probability of using insurance contracts in the wine industry of Chile. Binomial logit and probit models were applied using a sample of 84 firms.

MATERIAL AND METHODS

The sample

The data used in this study were compiled between January and October of 2007 through the application of a questionnaire on the sources of risk in the Chilean wine industry (for details, see Lobos, 2009). The questionnaire has seven sections and it was applied to enterprises located in most of the wine producing valleys of Chile. Each measurable variable was captured through the 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.

Section 1 refers to the commercial activity of the enterprise, the number of permanent workers, the perception of the wine grower concerning debt level, the negotiating conditions of the wine selling contracts, the access to price information in the domestic and international markets, and the ease of access to wine buyers. Section 2 helps to have an approximation of the degree of aversion to risk of the wine producers and of the importance they assign to the different types of risk they face and on the perception concerning the impact on the enterprise of the risks associated to the variability of wine prices and climatic changes.

The information about the new financial instruments for risk management as well as the knowledge and use of these instruments are presented in section III. Section IV captures information about the degree of use of insurance, the opinion of the wine producers about the adequacy of insurance as instruments for the management of risk and the expectations regarding the ideal characteristics of these instruments. Section V captures information about public instruments for risk management, the degree of knowledge and of use of said instruments, but impact on the financial situation of the enterprise, as well as of the desirable characteristics of the new instruments. The personal profile of the wine growers is viewed in section VI. The age, participation in the company's capital, investment in the stock exchange, sources for the acquisition of consultancy as modifying factors of attitude in face of the risk for winegrowers.

In this study a sample of 84 enterprises was used, somehow less than the one used in the works of Lobos and Viviani (2008) and Lobos (2009). The data was processed using SPSS v 15.0.

Dependent and explanatory variables

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

Establishing the mathematical models

All binary choice models, except the linear probability model, are usually estimated by the method of maximum likelihood (Greene, 1999; Wooldridge, 2006). The maximum likelihood method was proposed initially by Fisher (1922) and it is a classical estimation method of the parameters associated with density functions or random variables probability. Every observed indicator variable Y_i is considered as the individual realization of a binomial process which probabilities vary from one test to the other depending on each vector of independent variables x_{ij} (Maddala, 1996). A Bernoulli trial is a probabilistic experiment that can have one of two outcomes, success ($x=1$) or failure ($x=0$) and in which the probability of success is p (Evans *et al.*, 2000). We refer to p as the Bernoulli probability parameter.

Let y_i be a random variable with probability function $f(y;\beta)$, where β is an unknown parameter. Let $Y_1 = y_1, Y_2 = y_2, \dots, Y_n = y_n$ be the observed values in a random sample of size n . Given the supposition of random sample, the joint distribution of Y_1, Y_2, \dots, Y_n is simply the product of the individual density functions $f(y_1; \beta_1) f(y_2; \beta_2) \dots f(y_n; \beta_n)$. The likelihood function is defined as the joint density function of the random sample:

$$L(Y_i; \beta) = L(y_1, \dots, y_n; \beta) = f(y_1; \beta_1) f(y_2; \beta_2) \dots f(y_n; \beta_n) = \prod_{i=1}^n f(Y_i; \beta) \quad (1)$$

The likelihood function is a random variable, since it depends on the result of the random sampling Y_1, Y_2, \dots, Y_n and on the unknown parameter β . The maximum likelihood estimator (MLE) of β is the value of β that maximizes the likelihood function $L(Y_i; \beta)$. Usually, it is more convenient to maximize the logarithm of the likelihood function (log-likelihood function):

$$\log(L(Y_i; \beta)) = \sum_{i=1}^n \log f(Y_i; \beta) \quad (2)$$

Our interest is focused on the distribution of Y conditioned on a vector of explanatory variables x , let's say x_1, x_2, \dots, x_k . The density function $f(Y_i; \beta)$ can be written as $f(Y_i | x_1, x_2, \dots, x_k; \beta_1, \beta_2, \dots, \beta_k)$, which depends on k unknown parameters $\beta_1, \beta_2, \dots, \beta_k$ that are necessary to estimate. Replacing in the expression (2):

$$\log(L(Y_i; \beta)) = \sum_{i=1}^n \log f(Y_i | x_1, x_2, \dots, x_k; \beta_1, \beta_2, \dots, \beta_k) \quad (3)$$

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

Variables	Description
UseIC	Use of insurance contracts: «0» means that the wine-growing company doesn't use insurance contracts for risk management, «1» means it does
Constant	Constant term
TSurfaceV	Total surface planted with vineyards (ha): «1» if the surface is greater than 50 ha, «0» if it is less
WPricesA	Wine prices access: «1» if the access to the wine price references is easy, «0» if it is difficult
WMarketA	Wine market access: «1» if the access to wine market information is easy, «0» if it is difficult
SRisk	Sanitary risk: «1» if the sanitary risk is considered important as a risk source for the winegrower, «0» if not
ICRiskM	Insurance contracts risk management: «1» if the insurance contracts allow for an adequate management of the risks faced by the winegrower, «0» if not
EHedgingIC	Expected hedging insurance contracts: «1» if the expected coverage of the insurance contracts is high, «0» if not
CapitalP	«1» if the winegrower's participation in the company's capital is greater than 50%, «0» if it is less

To obtain the maximum likelihood estimators $\hat{\beta}_1, \hat{\beta}_2, \dots, \hat{\beta}_k$, the k partial derivatives of the likelihood function $L(Y_i; \beta)$ must be made equal to zero and solve the resulting system, as indicated:

$$\frac{\partial L(Y_i; \beta_1, \beta_2, \dots, \beta_k)}{\partial \beta_i}, i = 1, \dots, p \quad (4)$$

In the particular case of a binary choice model, we are interested in the response probability:

$$P(y = 1|x) = P(y = 1|x_1, \dots, x_k) = G(\beta_0 + \beta_1 x_1 + \dots + \beta_k x_k) = G(\beta'x) \quad (5)$$

In expression (5) x is a vector of explanatory variables and β' is a vector of parameters that include the intercept. The 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, the function G is the cumulative distribution function (CDF) of the standard logistics, expressed as:

$$G(z) = \frac{\exp(z)}{1 + \exp(z)} = \frac{1}{1 + \exp(-z)} = \frac{1}{1 + \exp(-\beta'x)} \equiv \Lambda(z) \equiv \Lambda(\beta'x) \quad (6)$$

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

$$G(z) = \int_{-\infty}^z (2\pi)^{-1/2} \exp(-z^2/2) dz \equiv \Phi(z) \equiv \Phi(\beta'x) \quad (7)$$

The logit and probit models can stem from a latent variable underlying model (Wooldridge, 2006). Let y^* be a non observed variable, or latent variable, determined by:

$$y^* = \beta'x + \varepsilon, y^* = \ell(y^* > 0), \quad (8)$$

The indicator function $\ell(\cdot)$ is a binary variable of results, where y takes the value one when $y^* > 0$, and zero when $y^* \leq 0$. It is assumed that ε is independent of x and that it follows a standard logistic distribution (logit model) or normal typified distribution (probit model). In addition, it is assumed that ε is distributed symmetrically around zero, which implies that $1 - G(-z) = G(z)$ for every real value of z .

The response probability of Y is obtained as:

$$P(y = 1|x) = P(y^* > 0|x) = P(\varepsilon > -\beta'x|x) = 1 - G(-\beta'x) = G(\beta'x) \equiv G(z) \quad (9)$$

Note that this previous expression is coincident with (6) and (7) of the standard logistics and the normal typified logistics, respectively.

Goodness-of-Fit Tests

To evaluate the goodness-of-fit of the models, different statistical tests were used. McFadden's R2 is also known as the likelihood-ratio index. It compares the likelihood for the intercept only model to the likelihood for the model with the predictors (McFadden, 1973). In the discrete selection models, the McFadden's R2 does not have a direct interpretation, and it is considered that the best model is the one that presents a greater statistical value.

Akaike's Information Criterion (AIC) is not a test of the model in the sense of hypothesis testing; rather it is a tool for model selection –or test between models (Akaike, 1974). Given a data set, several competing models may be ranked according to their AIC, with the one having the lowest AIC being the best. When estimating model parameters using maximum li-

likelihood estimation, it is possible to increase the likelihood by adding parameters, which may result in *overfitting*¹. The Bayesian Information Criterion (BIC), or Schwarz Criterion, resolves this problem by introducing a penalty term for the number of parameters in the model. Given any two estimated models, the model with the lower value of BIC is the one to be preferred (Schwarz, 1978). The Hannan-Quinn Criterion (HQC) is an alternative to AIC and BIC criterions. However HQC statistic usually punishes a model with more parameters more than the AIC, but not as severely as the BIC (Hannan and Quinn, 1979).

Similarly, goodness-of-fit evaluation of the models can be done by means of Likelihood Ratio statistics (LR) –Omnibus tests– is a test of the null hypothesis that adding the gender variable to the model has not significantly increased our ability to predict the decisions made by our subjects. The -2LL (-2 Logarithm of the Likelihood) measures how poorly the model predicts the decisions –the smaller the statistic the better the model. Under the null hypothesis that the model fits perfectly, -2LL has a chi-square distribution, with (N-p) degrees of freedom, where N is the number of cases and p is the number of estimated parameters (Hosmer y Lemeshow, 1989).

On the other hand, Hosmer and Lemeshow (1980) proposed a Pearson chi-square statistic based on a grouping of the estimated probabilities. The R² Cox & Snell can be interpreted like R² in a multiple regression, but cannot reach a maximum value of 1. The adjusted Nagelkerke (1991) R² can reach a maximum of 1.

Finally, it is possible to evaluate the predictive power of the logit and probit models using Receiver Operating Characteristic (ROC) curve analysis (Lloyd, 1998, 1999; Cai and Pepe, 2002; Zhou and Castelluccio, 2003). The ROC curve represents, on a coordinate system, the *sensitivity* and the *specificity* for different cut-points. The sensitivity is the proportion of cases classified as 1 and that in effect are 1 and specificity is the proportion of cases classified as 0 and that in effect are not 0 for cut-point 0.5. 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).

General characteristics of the companies in the sample

It is worth noting that the formal Chilean wine industry is composed of 230 enterprises with very homogeneous characteristics among them in terms of vine planted surfaces, volume and value of sales, number of permanent workers, inversion in advertising, market power in the domestic wine and grape

market, among others. As a reference, less than 10 companies have more than 1 000 planted hectares, less than 30 companies have more than 300 planted hectares and less than 50 companies have more than 100 planted hectares. In short, the big wineries are relatively few in number, whereas the main group is composed of the intermediate and small size wineries, which compete intensely in the domestic market. On the other hand, if we consider the number of properties with wine vines, there are over 14 000 in Chile, of which a little more than 13 600 have less than 50 hectares, that is, around 97%.

The sample includes wineries located in the main wine producing valleys of Chile: Aconcagua (8%), Maipo and Rapel (13%), Curicó (11%) and Maule (54%). The companies included in the sample have a total of 27 885 ha planted with vines, which represent 27% of the total surface with wine grapes for 2008 in Chile. 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).

RESULTS

The main purpose of this study is to identify the variables that have an influence on the probability of using insurance contracts in the wine industry of Chile, based on the influence that a set of socioeconomic variables and the winegrowers' own perceptions have on the willingness to take insurances. The explanatory variables that finally turned out to be significant are related mainly to the perceptions of the winegrowers: ease of access to prices and wine markets, perception of the sanitary risk, perception of the insurance contracts and expected coverage. Only the socioeconomic variable concerning the surface planted with wine grapes turned out to be significant in the models.

Logit and probit models

The results of the multiple regression models are shown in Table III. Parameters estimated and z-statistics of all the variables are presented. The sign on TSurfaceV is positive and significant at the 5% level. This result suggests that the winegrowers are more willing to take insurance contracts when the surface planted with wine grapes is large (more than 50 ha). The sign on WPricesA is negative and significant at the 5% level. This result suggests that the winegrowers perceive a lesser need to take insurance contracts when they estimate that the access to references of the price of wine is easy. The sign on WMarketA is positive and significant at the 1% level. This result shows that when winegrowers estimate that the access to wine market information is easy, they are more

¹ In statistics, overfitting occurs when a statistical model describes random error or noise instead of the underlying relationship (Schwarz, 1978).

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
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 of companies:	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 vineyards	14	20,6
Large vineyards	54	79,4
Total of companies:	68	100

^aThe total doesn't necessarily correspond to the size of the sample (84 companies). The differences are "lost" data.

^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) method
Resultados dos modelos de regressão múltipla estimados pelo método "Maximum Likelihood" (ML)

Regressors	Logit	Probit
Constant	-4.682672* (-2.134577)	-2.808726* (-2.206332)
TSurfaceV	4.046724* (1.965887)	2.422142* (2.021988)
WPricesA	-4.433209* (-2.400392)	-2.636083* (-2.445666)
WMarketA	5.788132** (2.880377)	3.465528** (2.920734)
SRisk	-3.472124* (-2.020477)	-2.066895* (-2.099443)
ICRiskM	4.571732** (2.700541)	2.710375** (2.811327)
EHedgingIC	-3.773640* (-2.498678)	-2.249192** (-2.602492)
CapitalP	1.878712 (1.248510)	1.116234 (1.342590)

Data computed from the survey. z-statistic in brackets. The dependent variable is the binary variable UseIC. *p<0.05, **p<0.01, ***p<0.001. Variables explained in Table 2.

willing to take insurance contracts. The opposite signs of the coefficients of the variables WPricesA and WMarketA show an apparent contradiction. However, the variable WPricesA refers specifically to the access to wine price information and if the winemaker estimates that the access to this type of information is easy, then it is less probable that he will be willing to use, for instance, a wine price insurance. On the other hand, the variable WMarketA refers to the access of market information, which is wider than the price information since it can consider the access to strategic information like, for instance: variables that have an influence on the consumer's decision as to which wine to buy, what are the tastes and preferences of the consumers, what are the commercialization mode of wines, what are the competition's commercialization channels, how are the prices determined in times of wine offer and how much are the prices reduced related to the normal price. Then, since the risk and uncertainty associated to market information spans over different sectors, a greater willingness to use insurance can be explained when the winemaker has easier access to market information, because this information is associated with different risk and uncertainty generating sources.

The sign on SRisk is negative and significant at the 5% level. This result shows that when winegrowers perceive that the sanitary risk is a significant source of risk, they are less willing to take insurance contracts.

The sign on ICRiskM is positive and significant at the 1% level. In other words, winegrowers are more willing to take insurance contracts when they estimate that the insurance contracts allow them to manage adequately the risk they face. The sign on EHedgingIC is negative and significant at the 5% level. This result indicates that winegrowers are less willing to take insurance contracts when the expected coverage is high. Finally, the sign on CapitalP is positive and not significant. This result, even though it is not statistically significant, suggests that winegrowers are more willing to take insurance contracts when the winegrower's participation in the company's capital is high (greater than 50%).

Goodness-of-fit evaluation: logit and probit models

The results of the evaluation of the goodness-of-fit statistics of the models suggest that the probit model has a greater degree of efficiency in explaining the willingness to use insurance contracts by the Chilean winegrowers (see Table IV). The pseudo McFadden's R2 (the highest value) and the AIC, BIC, HQC criteria (the lowest values) suggest that the probit model is more suitable than the logit model to explain the willingness to take insurance contracts. 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. The high values in Cox & Snell R2 and adjusted R2 Nagelkerke are associated with a good fit of the logit model.

Expectation-Prediction evaluation and ROC curve

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 83.33% for logit and probit models. On the other hand, the sensitivity (85.71%) is greater than the specificity (81.10%) for the cut-point of 0.50. The area under the ROC curve suggests that there is a probability of 83.10% that considering two

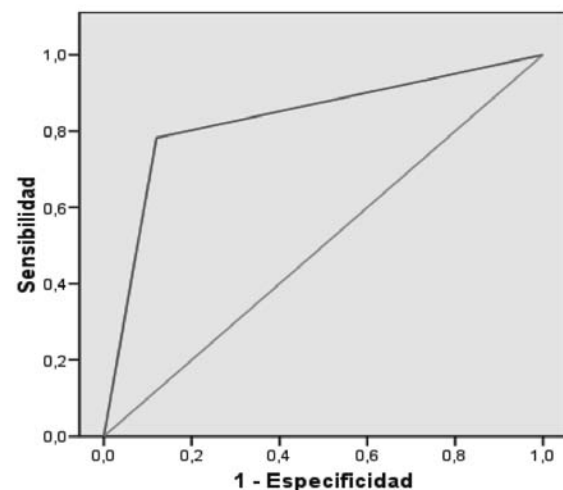


Fig. 1 - ROC curve for binary specification of the models estimated via Maximum Likelihood (ML) method.

Curva ROC para especificação binária dos modelos estimados via Maximum Likelihood (ML)

companies, one using insurance 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 major virtue of the study reported here is that it is the first empirical research of vineyards purchase intentions with respect to risk management insurance. The study is necessarily exploratory, but like most exploratory studies, the results are based on a sub-optimal sample. The sample used here is small (N=84), confined to recognized vineyards, and fairly homogenous in terms of characteristics such as production processes, location and markets for the wine.

This study has also shown the usefulness of the discreet selection models (logit and probit) to help identify the firm's individual characteristics that have an influence on the probability of using insurance

TABLE IV

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

Statistic	Logit	Probit
McFadden's R ²	0.578494	0.586020
Akaike's Information Criterion (AIC)	0.911062	0.900746
Bayesian Information Criterion (BIC) or Schwarz Criterion	1.222929	1.212613
Hannan-Quinn Criterion (HQC)	1.028917	1.018601
Likelihood Ratio statistic (LR) – Omnibus tests	38.05920***	38.55436***
-2 Logarithm of the Likelihood (-2LL)	27.731***	38.554***
Pearson's chi-square test	25.017 Prob(Pearson): 0.969	24.258 Prob(Pearson): 0.977
Hosmer-Lemeshow (HL) chi-square statistic	7.48876 Prob(HL): 0.4849	7.19995 Prob(HL): 0.5152
Cox & Snell R ²	0.547	-
Adjusted R ² Nagelkerke	0.734	-

Data computed from the survey. ***p<0.001

TABLE V

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

Observed cases	Estimated equation for probit and logit models			% Correct
	UseIC=0	UseIC=1	Total	
UseIC=0	22	3	25	88.00
UseIC=1	5	18	23	78.26
Total	27	21	48	.
Correct	22	18	40	.
% Correct	81.48	85.71	.	83.33
% Incorrect	18.52 [†]	14.21 ^{††}	.	16.67
% Total	100.00	100.00	.	.
% Area under the ROC curve		83.10		

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

contracts as instruments of financial coverage for the management of the principal risks that Chilean winegrowers face. The descriptive analysis allows inferring about the influence that a set of socioeconomic variables and the winegrowers' own perceptions have on the willingness to purchase insurances. The estimators of the probit model are related to approximately 0.6 of the logit estimators, close to the proportion of 0.625 that the literature suggests (Amemiya, 1981; Maddala, 1996).

In general, the sign of the coefficients confirm the previous perception about the factors that influence positively about the probability of purchasing insurance. This is there is a greater disposition to use

insurance in the case of the larger vineyards, when winegrowers estimate that the insurance contracts allow them to manage adequately the risk and when the winegrower's participation in the company's capital is high. The findings of Shaik *et al.* (2008) about the positive relationship between the disposition to purchase insurances and the acreage under irrigation seem to be similar to the positive relationship between the willingness to take insurance and the size of the vineyard measured as the surface planted with vines. The significance of the winegrower's participation in the company's capital is consistent with the eventual existence of an Agency Problem, or a conflict of interest arising between shareholders and managements

because of differing goals.

Some factors that have a negative influence on the probability of taking insurances also agree with the previous perception. For example, when winegrowers perceive that the access to the price of wine references is easy (i.e., when there exists perfect information in competitive markets for the wine). In an opposite sense, when winegrowers perceive that the access to the wine price references is difficult (i.e. when there is uncertainty about the expected prices) they will be more willing to use insurance, which seems consistent with the work of Shaik *et al.* (2008) in the sense that farmers perceive a need to purchase insurance when expected prices are low.

The positive relationship between the probability of taking insurance and the size of the plantations, in which the former could be considered as a proxy of the wealth variable (stock), suggest that the vineyards that have a greater economic value will be more ready to take insurances. The same positive relationship can be observed between the willingness to purchase insurance and the winegrower's participation in the ownership of the company, although this last variable was not significant. However, the aforementioned relationships lead in the same direction than the findings of Nielsen and Mayer (2000) and Tan *et al.* (2009) for the purchase of personal coverage, this is, a positive relation between higher-income consumers (or greater wealth in present value) and purchase of life insurance policy. Unlike the work of Miador *et al.* (1986) that included as explanatory variable the return on total investment for the case of acquisition of non-life insurers, in the present study were not included the explanatory variables related to the financial situation of each company. It was only tried with the variable sales income (in millions of dollars), which turned out to be non significant.

The variables related to the experience of the producer, the relative production of the company, amount of farm-related debt, education level and the variability of yield, included in the Works of Smith and Baquet (1996) and Huber (2005), were considered in the models, but they turned out to be non significant. The producer's risk aversion was included in our estimations, but it was not significant, as reported in the works of Chambers and Quiggen, (2002) and Shaik *et al.* (2008).

Surprisingly, winegrowers are less willing to take insurance contracts when the expected coverage of the contracts is high, contrary to what the works of Knox and Richards (1999) and Shaik *et al.* (2008) suggest. However, this apparent contradiction could be explained due to the fact that the coverage and the upon expected premiums to insurance are not aligned with the real needs or expectations of Chilean winegrowers. The current offer of insurances corresponds to standardized instruments that can be taken by any company and are not specific to a particular industry. In fact, Chilean winegrowers would like to

find an insurance contracts offer that would have a greater coverage of the agriculture risks (i.e. drought, diseases, pests), with lower premiums, less complex and more accessible (i.e. that they could be taken over the phone, at fairs, at winegrowers fairs and in congresses). However, our results also show that producers are more willing to take insurances if they perceive that these contracts allow for an adequate management of risk.

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 model over the logit. 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.

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