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WILLINGNESS TO PAY FOR WEATHER-BASED INDEX INSURANCE IN MILK PRODUCTION

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Abstract

Recibido: 03/2019

Aceptado: 06/2019

Palabras clave

Willingness to pay.

Contingent valuation.

Index insurance

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This paper proposes the use of a weather-based index insurance for managing production risk in dairy farms of Argentina. We analyse the potential use of this product to protect against the risk of reduced milk production caused by extreme weather conditions (rainfall and temperature). Using milk producer survey data and contingent valuation method we estimate willingness to pay for a potential insurance policy. The survey was conducted in the central region of Argentina and 165 milk producers were surveyed. Design of the contingent valuation method considers the specific characteristics of the potential product and four premium rates. Using standard willingness to pay techniques, we assess the premium rate that milk producers are willing to pay. In general milk producers appear willing to pay premium rates of 6 to 12 percent for the hypothetical insurance product.

ISSN: 2250-687X - ISSN (En línea): 2250-6861

DISPOSICIÓN A PAGAR POR SEGUROS DE ÍNDICES CLIMÁTICOS PARA PRODUCCIÓN LECHERA

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Resumen

KEYWORDS

Disposición a pagar.

Valuación contingente.

Seguros paramétricos

El trabajo analiza la valoración por un seguro de riesgo climático en productores de leche en Argentina. Se analiza el uso potencial de este tipo de seguros como mecanismo de cobertura ante disminuciones de producción de leche causadas por condiciones climáticas adversas tales como inundación, sequía y altas temperaturas. Mediante la implementación de una encuesta a productores se estimó la disposición a pagar (DAP) utilizando métodos de valoración contingente. El producto que se trata de valorar es un seguro paramétrico basado en un índice de precipitaciones y temperatura. De acuerdo con las estimaciones los productores estarían dispuestos a pagar una prima entre 6% y 12% del total de los litros de leche asegurados.

ISSN: 2250-687X - ISSN (En línea): 2250-6861

INTRODUCTION

Production variability due to climatic events is a significant issue for farmers in Argentina. For example, the coefficient of variation (CV = standard deviation/mean) of wheat yields in Argentina (18 percent) is similar to that of Australia, a country considered to be subject to considerable yearly variation on yields (Anderson, 1979). This CV is substantially higher than that found in the US (6.7 percent) the European Union (6.1 percent) and Canada (10.7 percent). For corn, yield variations from trend are 12 percent in Argentina, as compared to 9 percent for the U.S. As an example of the impacts of climatic variability, the 2008/2009, 2011/2012 and 2017/18 droughts in Argentina resulted in a production shortfall of 20/30 percent of total soybeans production each one with total economic losses are estimated in 15 US$ billion (SEPSI-UBA, 2018).

In Argentina, as in many Latin American countries, poor functioning of financial markets limits the possibilities of smoothing inter-year income variability. Futures and options markets - of major importance both for price forecasting as well as for the transfer of risk - are insufficiently developed. In these countries variability of agricultural production translates directly into farm-level income variability: export demand for agricultural products is perfectly elastic, thus the impact of "bad" years due to climate is not dampened by price increases. This contrasts with the US, where national production shortfalls can be expected to result - at least partially – in some price increases.

Production risk can have different types of consequences on the farmers, rural areas and the country as a whole. For farmers it can result first, in a decrease in welfare due to the need to adapt to inter-year fluctuations in net incomes. Consumption patterns may be affected, in particular if capital markets do not allow (or allow at a high cost) borrowing in times of financial stress. This of course is more significant for limited-resource producers, where net income levels are not much higher than yearly household consumption. Production risk can also result in allocative inefficiency: for example a "safety first" (e.g. see Anderson, Dillon and Hardaker, 1977) behavioral pattern may sacrifice profits in order to reduce the probability that profits fall below a certain threshold. In other cases, "conservative" behavior may imply using input levels such that marginal costs are below output prices thus resulting in a loss of net surplus. Alternatively, risk may push farmers into using "excessive" input amounts: for example, under grazing production systems livestock producers may choose "low" stocking rates (low cattle/land ratios) in order to protect themselves against shortfalls in forage production due to drought or excessive rainfall. Or they may invest in forage reserves in the form of silage or hay inventories "in case" pasture production is insufficient. Such inventories, of course, carry a cost.

Production risk may have impacts beyond the farm gates. The fortunes of rural areas are partially "tied" to what happens in farms. Although caution has to be used in using "multiplier" type of concepts (double counting is a possible error) it appears reasonable to expect "ripple" effects of farm shorfalls on the communities in which farms rely on. Input and credit suppliers, output processors as well as consumer goods retailers are affected by reduced farm incomes. In some cases severe output shorfalls may also result in increased opportunism and moral hazard: for example, non-payment of debt may be chosen by some even when objectively, payments could be met. This results in an increased difficulty in separating opportunists from those who face real difficulties. Reduced trust among community members may thus result, with a corresponding reduction in exchange and thus efficiency.

Research pertaining on the impact of production variability (and thus risk-transfer mechanisms such as insurance) on agricultural production in Argentina is almost non-existent. Some farm-management studies have been carried out, but in general these have not addressed public policy issues. Most work that has been done has a normative (i.e. the derivation of "optimal" farm plans in the face of uncertainty) as opposed to positive (i.e. the impact of risk on technology adoption) flavor. In summary, risk is perceived as "an important" issue by informed observers, however no clear-cut evidence exists on the implications of this risk at the micro or aggregate levels or how to manage risk using new products as index based insurance policies.

This paper analyzes an insurance product for milk production using a weather based index. We propose and design an insurance product to protect against the risk of reduced milk production caused by weather variability in the central region of Argentina. This is a new agricultural risk management product, not available in the Argentinean insurance market, and we assess the value to agricultural producers estimating the willingness to pay for this hypothetical insurance policy using the contingent valuation method. We analyze farm-level data collected from a survey of milk producers in 2010. The paper is organized as follows: in the next sections we provide a brief account of the milk production Argentina, the proposed insurance scheme and a discussion of the survey and data. Then we present the contingent valuation method used to estimate the willingness to pay and the variables used in the analysis. The final sections present empirical applications, results and conclusions.

MILK PRODUCTION AND AGRICULTURAL INSURANCE

Argentina is an important producer and exporter of dairy products. High per-capita milk production results also in an important insertion of the dairy sector of Argentina in export markets. This indicates high potential payoffs of research efforts aimed at reducing production risk via insurance.

An important challenge for both public policy as well as private insurance firms is how to expand "non-traditional" insurance products, and in particular how to develop multi-risk coverage for producers. In Argentina, hail and hail plus "additional" insurance premiums account for more than 95 percent of total premiums, multirisk premiums totalling less than 2 percent. Existing multirisk insurance schemes are tailor-made for individual (in general relatively large) farms. These schemes result in an indemnity if yields fall below certain threshold, indemnity being the difference between the threshold and the observed yield. Insurance schemes such as these high costs, further costs per unit of land increase substantially for smaller as compared to larger producing units.

Index- (or "parametric) based insurance schemes allow reduction in delivery costs (including in these moral hazard and advese selection costs). However, they require substantial set-up costs in the form of (i) information on yields, (ii) potential impact of contract design alternatives. Low correlation between area and farm yields (and thus "basis risk) for the insured remains a significant problem. Research done in Argentina, however, shows considerable potential for some multirisk insurance alternatives (Galetto, Lema and Gastaldi, 2011).

This paper focuses on the possibility of obtaining welfare or production efficiency gains trough the use of insurance in dairy production. From a policy view, public intervention (e.g. in the form of improving the availability of farm-level yields, or site-specific climate information) may help the decision process of both suppliers and demanders of insurance. If this occurs, efficiency gains could result.

However, the estimation of benefits derived from insurance is a necessary first step in order to decide whether publicly-sponsored projects such as mentioned should be undertaken.

These benefits can be gauged by different methods. Among these willingness-to-pay (WTP) is a convenient and well-tried alternative that allows inferences to be made on aspects such as quantity demanded at different prices, consumer (or producer) surplus and other aspects (see, e.g. Hanemann, 1984; Kealy, Montgomery and Dovidio, 1990; Mitchell and Carson, 1989).

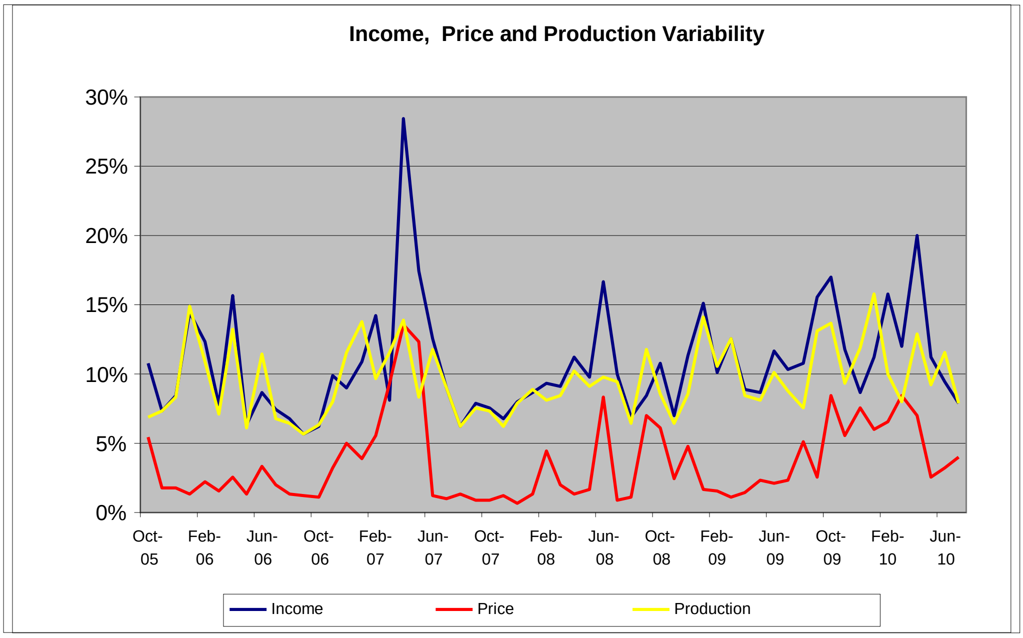
WTP for insurance will vary substantially among production regions and farm types. This occurs because alternatives open to the farmer for risk reduction include not only insurance but production diversification, access to the non-farm labor market, renting out machinery or land and others.

In the last 20 years the relative importance of the domestic and export markets for milk production has been rather stable, with a 75-85 % of output for domestic consumption and 15-25 % for exports (on a milk-equivalent basis), mostly in the form of whole milk powder (WMP). More than 80 % of Argentina´s dairy exports are concentrated in the Latin American and African markets. Although the share of exports is low in comparison with the participation of the domestic market, the dairy market in Argentina is fully integrated with the world market, particularly regarding the formation of domestic prices at different stages to the dairy chain (Rossini, Vicentín, García Arancibia y Coronel, 2013). Without entering into a detailed analysis of the nature of price transmission between world and domestic dairy markets, one of the main factors explaining the price integration between international and domestic markets is the competitive nature of the dairy sector in Argentina (Vicentín Masaro, 2017).

Dairy production is an important activity for small and medium farmers and risk reduction strategies are important for these farmer groups. Further, dairy production is by far the most capital-intensive livestock production enterprise. It also accounts for a significant (and growing) portion of output of the livestock sector in Argentina, Prevalence of small and medium farms, high capital intensity, coupled with dependence of the dairy farm on climate inputs results in risk management being a topic of primary importance.

In this study, attention is centered on production as opposed to revenue insurance. It is assumed that there is a relationship between weather conditions and production that could be assessed and a potential insurance policy designed. Indemnity payments are triggered by rainfall or temperature index falling below certain threshold. From a farmer's perspective, the relevance of this type of insurance product depends of course on whether income variability is caused primarily by output or alternatively by price variability. In case of the former, yield-based insurance will be a significant factor in reducing risk. In case of the latter, risk reduction will be more easily achieved by the use of futures and options markets and similar mechanisms.

Figure 1. Sources of income variability



Source: Authors elaboration.

Figure 1 allows additional insights relative to sources of risk at the farm level. The figure shows, for the period October 2005 – June 2010 absolute variations with respect to the previous month 100*│(xt – xt-1)/xt│ of (i) revenue (pxq), (ii) prices and (iii) quantities using micro-data of 200 dairy farms located in the central region of Argentina. As reported, variations in output are considerably higher than variations in prices. This suggests that insurance schemes where indemnities are based on output shortfalls have considerable potential for stabilizing incomes.

CLIMATE AND DAIRY PRODUCTION

Milk production is sensitive to climate because dairy cows that are exposed to high ambient temperature and humidity usually respond with reduced milk production as cows consumed less feed and thus produced less milk under these conditions. Also, at a given high temperature, cows exposed to low humidity performed better than those exposed to high humidity. Dairy livestock are sensitive to extreme weather conditions and milk production is negatively affected, in particular, by excessive rain and by high temperatures. The lack of rain, or drought, also affects milk production, but with different patterns, since the effect is mostly indirect through reduced pasture production, and the farmer can take actions to alleviate the productive impact of the drought, although at the cost of higher input use (for example, by purchasing more concentrates from outside de farm).

In the case of excessive rain –which is aggravated by the soils characteristics of the areas where milk production is located in Argentina - and high temperature and humidity, the farmer has almost no alternative open to him to adopt alleviation practices once the event has occurred, since most of the measures need to be taken in advance, in a decision situation characterized by the occurrence of the uncertain event.

For example, to be prepared for a situation with excessive rain (normally in the fall season) the farmer has to invest in dry locations, with or without roofs, and specialized machinery (mixers) to feed the cattle. In the case of high temperature and humidity, the protective measures include the use of shadow (whether it be artificial or natural), and a battery of cooling systems mostly installed within or near the milking

Adaptation measures in production and technology adoption are used to cope with risk in milk production, but in case of extreme weather events are not fully effective. For these extreme cases we propose an index-based product.

INDEX INSURANCE DESIGN FOR MILK PRODUCTION

In recent years, weather index insurance products have received increased attention. For economic agents exposed to weather-related financial losses, weather index insurance provide a mechanism for coping with risk efficiently. The benefits to such a contract design are several and appropriate to rural areas where covariate risk, asymmetric information and high transactions costs implies that conventional insurance is not available. Insurance companies and insured clients need only monitor the index to know when a claim is due and indemnity payments must be made. They do not need to verify claims of individual losses, which can substantially reduce the transactions costs of monitoring and verification of the insurance contracts. These gains come at the cost of *basis risk*, which refers to the imperfect correlation between an insured's potential loss experience and the behavior of the underlying index on which the index insurance payout is based. A contract holder may experience the type of losses insured against but fail to receive a payout if the overall index is not triggered. Conversely, while the aggregate experience may result in a triggered contract, some insured individuals may not have experienced losses yet still receive payouts. The tradeoff between basis risk and reductions in incentive problems and costs is thus a critical determinant of the effectiveness of index insurance products.

Agricultural applications of index insurance products are increasingly being discussed since many agricultural production enterprises are highly sensitive to extreme weather conditions (see e.g. Turvey, 200; Vedenov and Barnett, 2004; Deng, Barnett, Vedenov and West 2007, Binswanger-Mkhize, 2012; Carter, de Janvry, Sadoulet and Sarris, 2014; Morkink, Clarke and Mapfumo, 2016).

Following previous studies on index insurance for dairy production in Argentina (Gastaldi, Galetto and Lema, 2009 and Galetto, Gastaldi and Lema, 2011) we propose a weather index insurance to managing milk production risk. The product is a rainfall and temperature–humidity index insurance product to protect against the risk of reduced milk production caused by rainfall and heat stress in the central basin region of Argentina. The index insurance contract has several components. First, it requires a well defined index and an associated strike level that triggers an insurance payout. To be well defined, the index must be highly correlated with the aggregate loss being insured and based on data sources not controlled by either the insured or the insurer. In Gastaldi, Galetto and Lema (2009) and Galetto, Gastaldi and Lema (2011) the Standardized Precipitation Index (Mc.Kee, Doesken and Kleist,1993) and the Humidity and Temperature Index (Jones and Hennessy, 2000) are proposed to design an index insurance contract in milk production. These authors used farm level panel data and climatic information to estimate an econometric model to relate milk production and weather indexes. The index insurance contract was designed using data from milky farms in the main production region of Argentina.

The contract also specifies a clear payout timing and structure conditional on the index reaching the contractually specified strike level. For practical applications, the index insurance product is based on an index (I) of rainfall or temperature and humidity measured at the closest available weather station.

The insurance product would function much like a call option on the index. In particular, we define a contract that pays an indemnity conditional on the realization of the (I) according to the following schedule:

$$\tilde{n}_t(i_t | i_{strike}, \lambda) = \begin{cases} 0 & \text{if } i_t < i_{strike}, \\ i_t - i_{strike} & \text{if } i_{strike} \leq i_t < \lambda, \\ \lambda - i_{strike} & \text{if } i_t \geq \lambda \end{cases}$$

where $\tilde{n}_t$ is the indemnity for month (measured in liters of milk) t, i_t is the index (I) realization on month t measured at the weather station referenced in the insurance contract, i_{strike} is the strike, and λ is a choice variable that defines the upper bound of the layer of i over which indemnities are paid. The contract triggers an indemnity whenever i_t exceeds i_{strike}. The monthly maximum indemnity $(\lambda - i_{strike})$ is paid whenever it exceeds λ. Thus, the contract can be uniquely identified by fixing the two parameters i_{strike} and λ. The total indemnity paid on the contract over a period of T months is

$$\tilde{n}_t(i_{strike}, \lambda) = \sum_{t=1}^{T} \tilde{n}_t(i_t | i_{strike}, \lambda)$$

This is a contract design called "standard contract" and could be modified to allow the purchaser to scale the insurance liability up or down to meet individual needs.

WILLINGNESS TO PAY FOR WEATHER BASED INDEX INSURANCE

Despite the fact that index insurance in agriculture has been explored over the last years, the number of studies that focus on the demand for index-based products are relatively small. We propose the use of the price contingent valuation methodology to assess the willingness to pay for an index insurance product for milk producers.

The data for the study was collected through a farm level survey during the months of November and December 2010. We contacted and surveyed 165 milk producers, primarily in person using enumerators, in the central region of Argentina (See Map 1). Producers were selected randomly from a population of 500 farmers who are suppliers to a leading milk cooperative industry.

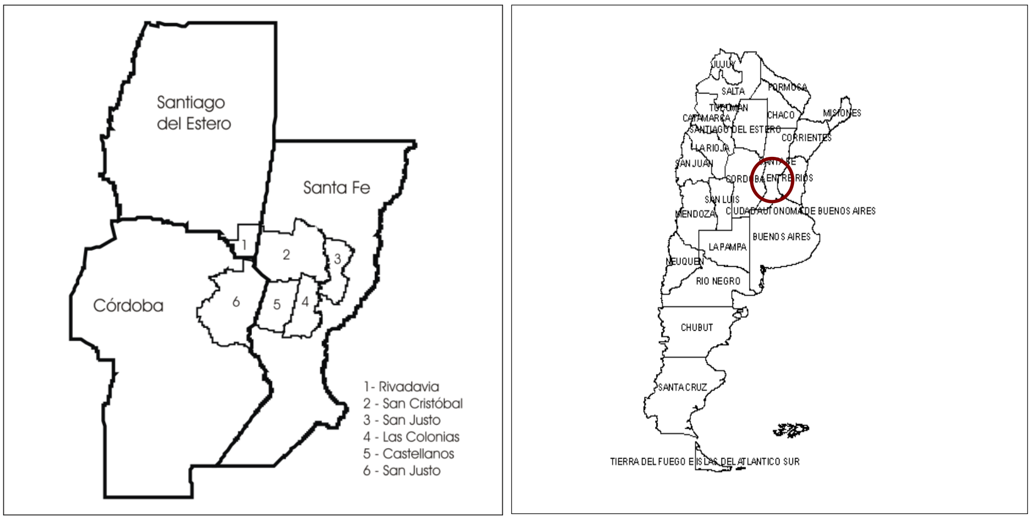
Respondent understanding of the mechanism of index based insurance was critical, thus each respondent was given an explanation about the index insurance and the hypothetical product and was asked questions to confirm understanding. The explanations was as follows:

Suppose that a company offers insurance against drought and excess rainfall events. The capital to ensure (coverage) is 15% of the monthly milk production in case of occurrence of an event. With a fixed component of 10% and 5% variable depending on the intensity of the event calculated from a weather index. That is, the milk producer always takes at least 10% (if the event occurs) and the remaining 5% is calculated based on the intensity of the event of drought or extreme humidity.

The occurrence and intensity of the event (drought or extreme humidity) is measured from an index built with rainfall and temperature information provided by Weather Stations in the area. If the index exceeds a certain pre-agreed value insurance is automatically triggered.

It is important to understand that compensation is paid and triggered by the climate index value without checking the damage. That is, you can collect the insurance and no loss of production and vice versa (because the association between the index and the output is high but not perfect).

Map 1. The Study Zone



Source: Authors elaboration.

We estimate the WTP using the results of the two survey questions presented below.

Q1 In the above example, would you be willing to purchase the insurance if the premium rate is ….. percent of the insured milk?

(Four pre-specified premium rates were randomly asked : 3%, 5%, 7% and 9%)

Q2. If your answer to Q1 is NO, would you be willing to pay any amount for this policy?

An affirmative answer to question 1 implies that the asked premium rate is the lower bound of the distribution of the WTP, while infinity marks the upper bound. Question 2 serves as a follow-up question. An affirmative response to question 2 indicates that zero represents the lower bound and the pre-specified premium rate represents the upper bound. A negative answer to question 3 means the lower bound of the distribution is negative infinity and the upper bound is zero.

The survey generates 165 usable responses. Table 1 presents the summary statistics of the data collected as well as how each variable was defined.

Table 1. Variable summary statistics and descriptions

Variable	**Mean**	**Min**	**Max**	**Std.Dev**
Age (years)	55	23	84	12,56
Education (Maximum level attained - 1=primary school; 2=high school;3=college degree)	1,72	1	3	0,75
Percentage of income derived from milk production (1=+80%; 2=60/80%; 3=40/60%; 4=-40%)	1,61	1	4	0,90
Farm Size (Total Farm Area in Hectares)	194	0	1.425	205,52
Number of cows (heads)	290	10	1.300	223,43
Use of Insurance Market (Yes=1; No=0)	0,47	0	1	0,50
Risk Aversion (Willingness to take financial risks in a 1 to 5 scale. 1=highly unwilling; 5= highly willing)	2,86	1	5	1,31
Milk Producción (year 2009-10 in thousand liters/year)	685,35	47,95	2.325,18	405,85
Zone 1 (Castellanos and San Justo County – Santa Fe Province)	0,40	0	1	0,49
Zone 2 (San Justo County – Córdoba Province)	0,27	0	1	0,45
Zone 3 (Rivadavia County –Santiago del Estero Province- and San Cristóbal County –Santa Fe Province)	0,33	0	1	0,47
Willingness to Pay (Index insurance at 3%, 5%, 7% or 9% premium rates) (Yes=1; No=0)	0,50	0	1	0,50
Willingness to pay any amount (Yes=1, No=0)	0,71	0	1	0,45

Source: Authors elaboration

ECONOMETRIC ESTIMATION METHODS

We estimated a probit model with sample selection (van de Ven and van Praag, 1981) to estimate mean WTP. Choosing to pay for a potential index based insurance product (at the specific coverage and asked premium rate) is contingent on whether an individual wants to buy the index insurance in the first place. Given the specific characteristics of the index insurance it is likely that some individuals do not want to buy index based insurance at any price[1]. Thus, individuals who stated that they did not want to buy index insurance at any price (i.e. that responded "No" to the follow-up question) could be classified as non users.

The probit model with selection has the following structure:

$$Y_{1i}^* = X_{1i}\,\beta_1 + \varepsilon_{1i}$$
$$Y_{2i}^* = X_{2i}\,\beta_2 + \varepsilon_{2i}$$

where Y_{2i}^* is the utility function of an individual reflecting one´s overall attitude towards an index based insurance (signified by a "No" response to buying insurance at any price) and Y_{1i}^* is the utility difference between buying the index insurance at the suggested price and not buying. X_{1i} and X_{2i} are the respective vectors of covariates for individual (i), β´s are the associated coefficient parameters and $\square_j$´s are respective error terms.
Y_{ji}^* and Y_{ji} are associated in the following manner:

$$\text{For every individual (i), } Y_{ji} = \left\{ \begin{array}{l} 1 \text{ if } Y^*_{ji} \geq 0 \\ 0 \text{ if } Y^*_{ji} < 0 \end{array} \right\} \text{ for j= 1, 2}$$

However, Y_{1i} is observed only if Y_{2i} =1.

The second probit equation is based on the complete sample and the first probit equation is based on a selected (or censored) sample.
The use of the selection model helps to dissociate the types of consumers (potential buyers and non buyers of insurance at any price) and rectify the potential selection bias.
Model specification was as follows. The selection model contained the variables *age, edu, production and risk* (See Table 2 for definition of variables).

[1] One important feature for the potential users is the difficulty in assessing the impact of a basis risk that occurs because the indemnities on a weather index insurance are not perfectly correlated with the actual losses.

Table 2: Definition of Variables.

Variable	**Definition**
WTP	Dummy variable (Yes=1)
Premium	Premium (%)
Cows	Number of cows (thousand of heads)
Age	Age of the farmer (years)
Edu	Education
Z1	Dummy Variable (Zone 1=1)
Z2	Dummy Variable (Zone 2=1)
Z3	Dummy Variable (Zone 3=1)
Selection	Dummy Variable (0 if "No" in response to Q1 and "No" in response to Q2. 1 otherwise)
Production	Milk Producción 2009-2010 (thousand of liters/year)
Risk	Risk Aversion

The production variable is included in the selection model under the assumption that preferences for insurance contracts vary with the size of the farm.

The WTP model includes variables *premium, age, education, cows, z2* and *z3*. The *premium* variable identifies the price of insurance, *cow* is a proxy variable of wealth. The variables *age, education, z1* and *z2* are controls for individual characteristics and location of the farm.

We fit the following joint maximum-likelihood function (van de Ven and van Praag, 1981) to estimate the model:

$$\prod_{i=1}^{N1}\phi_2(\beta_1^{'}X_{1i},\beta_2^{'}X_{2i};\rho).\prod_{i=N1+1}^{N2}\phi_2(-\beta_1^{'}X_{1i},\beta_2^{'}X_{2i};\rho).\prod_{i=N2+1}^{N3}\phi(-\beta_2^{'}X_{2i}) \quad (1)$$

Where observations 1…N1 are respondents willing to pay the stated premium rate, observations N1+1…N2 are respondents not willing to pay the stated premium rate but willing to pay some lower price and observations N2+1…N3 are "No", "No" respondents, $\phi_2(.)$ *is CDF of a bivariate normal,* ϕ is CDF of univariate normal distribution and ρ correlation between ε_{1i} and ε_{2i}. Estimation was done using the *Heckprob* procedure in Stata version 10. Mean WTP was calculated using the method for a lineal utility function described in Haab and McConnell (2002). To provide some additional information on the distribution of WTP we also calculated the Turnbull distribution-free mean estimator (Haab and McConnell, 2002).

ESTIMATION RESULTS

Table 3 contains the estimated coefficients and standard errors for both the selection and WTP equation. For the selection equation *production* has a positive and significant effect. For the WTP equation results indicate a positive and significant sign on the zone variables. The positive sign indicates that producers located in the riskier zones (2 and 3) are willing to pay a higher premium. The education variable is negative and significant in both equations, indicating that more educated people are less willing to pay for insurance. This unexpected result may follow from the fact that the more educated milk producers have more sources of off-farm income and, in consequence, their potential demand of insurance can be lower.

Table 3: Coefficient estimates. Probit model with selection.

Variable	Coefficient	Std. Error	P>|z|
WTP			
Premium	0.141***	0.047	0.00
Cows	0.503	0.508	0.32
Age	-0.016*	0.009	0.08
Edu	0.052	0.163	0.75
Z2	0.445*	0.254	0.08
Z3	0.825***	0.245	0.00
Constant	1.522*	0.802	0.06
Selection			
Production	0.001*	0.000	0.10
Age	-0.003	0.011	0.77
Edu	-0.303*	0.189	0.10
Riks	0.006	0.120	0.96
Constant	0.072	0.092	0.43
ρ	-0.999	0.076	
Observations	161		
Censored Obs.	25		
Non Censores Obs.	136		
Log likelihood	-146.22	Wald chi2(5) = 24.01	Prob > chi2 = 0.0005
LR test (ϱ = 0)		chi2(1) = 1.88	Prob > chi2 = 0.17

***Significant at 1%; **Significant at 5%; *Significant at 10%

Source: authors elaboration based on econometric estimates.

Table 4 presents the estimated WTP values based in the estimated coefficients, conditioning by zone and fixing the independent variables at the mean.

Table 4. WTP (Mean) by Zone

Zone	WTP (%)
Zone 1 (Rafaela County)	6,09
Zona 2 (San Francisco County)	9,25
Zone 3 (Ceres County)	11,94
Mean (Average Zone)	8,91

Source: authors elaboration based on econometric estimates.

Mean WTP is increasing from 6% in Zone 1 to 12% in Zone 3 a result that is consistent with the fact that in riskier locations the WTP is higher. On average respondents appear ready to pay a premium rate of 8.9% for the insurance.

Table 5 presents the relative frequencies used to calculate the Turnbull estimator. Table 6 presents the Turnbull lower bound estimate that results in a premium rate of 10.8% for the proposed insurance policy.

Table 5. Turnbull Estimator – Relative Response Frequencies

Premium (tj)	Negative Responses (Nj)	Total Responses (Tj)	F*j (Nj/Tj)	f*j (Fj+1-Fj)
3	13	44	0,2955	0,2955
5	20	41	0,4878	0,1924
7	24	40	0,6000	0,1122
9	25	39	0,6410	0,0410
9+			1	0,3590

Source: Authors elaboration.

Table 7. WTP (Mean) –Turnbull Estimator

	Mean (Lower Limit)	Std. Dev	Confidence Interval 95%	
WTP	10,78	0,34	10,12	11,45

Source: authors elaboration.

CONCLUSIONS

Our results suggest that milk producers apparently have an "effective" interest in insurance, that is, they are willing to pay for the product. Using survey data and standard willingness to pay techniques we assessed the premium rates milk producers are willing to pay for an index based insurance. In general producers appear willing to pay premium rates of 6 to 12 percent for insurance. Estimates of the pure (actuarial) premiums for this type of index insurance are on average 2.5 percent. Insurance companies usually increases this figures from 25% to 50% to cover administrative costs and other expenses (Galetto, Lema and Gastaldi, 2011). In consequence, the estimated WTP values are well above the estimated pure premiums, indicating that an index based insurance market could be profitable for insurance companies.

In final analysis, WTP estimates should provide guidance for answering the following question: Is it socially desirable to invest $ ***x*** in order to further the development of the agricultural insurance market? If (correctly) estimated WTP figures are greater than the actuarial plus administrative costs of providing index insurance, some kind of "market failure" is operative. That is "hidden" (i.e. additional to the ones mentioned previously) costs result in a low level of insurance supply relative to demand.

The provision for example of a public good such as improved information on climate to construct indexes could result in a shift in the supply function for insurance, with a corresponding increase in "consumer + producer" surplus.[2] The "benefit/cost" ratio of public intervention could then be calculated as the (present value) of the increase in surplus divided by the cost of producing the public good. WTP figures are then basic inputs for any discussion regarding the merits or otherwise of public intervention.

Research analyzing constraints to the development of parametric insurance alternatives should focus some attention on institutional/legal aspects that may hinder progress. In the case of Argentina the insurance industry is regulated by a specific law (Law N° 17418/1967) which requires an "in-situ" verification of the damages. Therefore, in the view of insurance regulators, index insurance schemes cannot be commercialized in Argentina as standard insurance products. This "conservative" view is typical of the standard government agency which shows prudent behavior before approving an innovation in the commercial market (such as index insurance). The "Superintendencia de Seguros" (agency in charge of regulating the insurance industry in Argentina) allowed in the year 2015 the operation of index insurance products but requires that the proposed insurance scheme be approved by the Risk Office (Oficina de Riesgo Agropecuario) of the Ministry of Agriculture. Private companies are actively exploring new parametric insurance schemes and this may of course change the market if the demand for these commercial products is sufficiently strong. Our research suggests that some attention should be focused in the demand side of the market.

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[2] In this case agricultural producers are consumers of insurance: i.e. demand for insurance is a derived demand.

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