Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria (INIA)
Available online at www.inia.es/sjar

Spanish Journal of Agricultural Research 2009 7(4), 0-778
ISSN: 1695-971-X

Is there a relation between risk rate and the insurance premium in agricultural insurances? An application to the citrus sector

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Abstract

Agricultural insurance has an essential role as a tool for risk reduction. This is especially important in a changing and uncertain environment as in agriculture. Insurance acts as a compensating mechanism of loss and risk transference between insured and insurer. This paper aims to find if there is a concluding relationship amongst the rates applied by insurance companies; the insurance premium applied to the insured farmers; the real risk level that farms face and the indemnifications that farmers get after a disaster. There were 418 citrus tree farms analysed in Murcia region (Spain) in the period 2002-2006. They were in the line called «Multicultivo de Cítricos y Complementario» (Citrus Multi-crop and Complementary). The correlation coefficients of the different analyses are close to zero (between 0.047 and 0.053). This indicates no relation between the real risk and the rate that insurance companies use. The rate is almost a constant, with no dependence on the risk of suffering damage. The main conclusion is that the present agricultural insurance system is not discriminating enough and the settlement of insurance premiums that insurance companies apply does not maintain any relation to the essential element that should direct an insurance contract: the risk that a disaster has occurred.

Additional key words: disasters, indemnity, insured, farms.

Resumen

¿Existe relación entre la tasa de riesgo y las primas repercutidas en los seguros agrarios? Aplicación al sector citrícola

El seguro agrario tiene un papel esencial como instrumento de reducción del riesgo, y más ante un entorno incierto y cambiante como es la agricultura, al servir de mecanismo de compensación de pérdidas y de transferencia de riesgos entre asegurado y asegurador. En este trabajo se pretende encontrar si existe una relación concluyente entre la tasa aplicada por las compañías aseguradoras, y por tanto de la prima aplicada a los asegurados (agricultores), el nivel de riesgo real que sufren las parcelas, y las indemnizaciones recibidas por los agricultores tras un siniestro. Se ha trabajado con 418 parcelas dedicadas al cultivo de cítricos en la Región de Murcia, en el período 2002-2006, y dentro de la línea «Multicultivo de Cítricos y Complementario». Los coeficientes de correlación de los diferentes ajustes realizados son muy cercanos a cero (entre 0,047 y 0,053), lo que nos indica una ausencia total de relación entre el riesgo real de siniestro y la tasa empleada por las aseguradoras. La tasa es prácticamente una constante, independiente del riesgo de sufrir algún tipo de daño. La conclusión a la que se llega es que el actual sistema de seguros agrarios no es lo suficientemente discriminante y la política de fijación de primas seguida por las compañías aseguradoras no mantiene relación alguna con el elemento esencial que debería marcar cualquier contrato de seguro: el riesgo de ocurrencia de un siniestro.

Palabras clave adicionales: asegurados, indemnización, parcelas, siniestros.

Introduction

The high dependence on weather (difficult to predict and impossible to control) is one of the main differences for agriculture compared with other economic activities. Farmers are especially vulnerable to a wide range of weather risks: hailstorms, floods, droughts, frosts, storms. The incidence of these factors leads to losses in production that can vary in intensity and frequency depending on the location and crops.

There is no country, region or area that is free of these risks. Obviously, there are significant differences

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Received: 24-04-09; Accepted: 08-09-09.

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depending on geography. On the other hand, weather effects on agriculture go beyond the individual and regional context and can become a global topic.

These conditions justify the existence of a mechanism that allows compensation for all the agents that play a role in a complicated economic scenario. This mechanism should be agricultural insurance. It faces three problems. Firstly, there is an economic aspect. Farmers have a finance element of guarantee and equilibrium that allows them to maintain their incomes avoiding the high level of uncertainty that their activity presents. Secondly, there is a social aspect strongly related to the economic aspect. The higher stability of agricultural activities allows development of rural areas and a better protection of the environment by farmers. Finally, there is a political aspect. Agricultural insurance as a tool of agricultural policy brings farmers into the system. They allow quantification of budget needs and permit a better development of the Common Agricultural Policy (CAP).

To develop an efficient agricultural insurance system is not an easy task. This is due to the variability of the damage, the lack of reliable data about damage, the effective calculation of real damage, the high cost of cover, the lack of companies with the capabilities to face farmer demands. However, agricultural insurance is one of the most efficient and effective mechanisms for reducing weather adverse economic consequences regarding its three aspects: economic, social and political. Its correct development is an essential tool to help farmers in managing and reducing a part of their risks (Burgaz, 1995, 2003, 2006; Castro, 1995; Vidal *et al.*, 1998; Garrido, 2002).

The main objective of this paper is to analyze the relationship amongst the rates and the insurance premium applied by insurance companies to insurance holder (farmer), the real risk that the farms have to face due to any of the damage included in the insured risks, and the relationship of the previous variables with the indemnification received by the farmer after the damage valuation process. Results could help to revise and propose alternative policies for insurance premium calculation.

Risk and agricultural insurances

Agricultural insurances have three objectives regarding a country's agriculture. Firstly, they allow farmers to reduce their vulnerability to economic and production risks that are not controlled. By doing so the farm incomes are more stable and the possibility of bankruptcy is reduced. On the other hand, they favour the creation of general wealth because they avoid producers employing economic resources for protecting themselves from risks. A broad and general insurance system can assume these risks at a lower cost because of its capacity to compensate loss among risks created by independent factors. The risk transference between insurant and insurer according to actuarial criteria increases benefit to both without detriment. Finally, they ensure a self-compensating mechanism in advance of disasters. Government having to create extraordinary measures to compensate farm damages is avoided. Agricultural insurances constitute an essential tool for helping farmers to manage and eliminate a part of their risks (Garrido, 2002).

Several surveys have looked at the role of agricultural insurances as a risk reduction tool. This role is essential in an uncertain and changing environment. Risk management, classification and strategies are important in this context. If we look at the last decade, we can mention European Commission (1999, 2001, 2005), Harwood *et al.* (1999), Lence (2000), USDA (2000), Moschini and Hennessy (2001), Garrido (2002), Just and Pope (2002), MAPA (2003), ENESA (2004), IICA (2004), Antón (2006), Bensted-Smith (2006) or European Parliament (2006).

So, risk is an intrinsic feature of agricultural activity. Strategies based on an insurance system (both public and private) are one of safest that can be developed. They also allow a higher warranty for maintaining business activity. Its efficacy depends on an accurate risk valuation both for insurance premium and indemnification settlement levels (Pérez-Salas, 2003).

Other researchers have pointed to risk clarification trying to bring criteria for improving efficiency in valuations. So, Segura *et al.* (1998, 2000), Vidal *et al.* (1998), Pérez Salas (2001, 2002a) or Pérez-Salas *et al.* (2001) especially look at harvest and damage valuation (samples, output estimation procedures, etc.). However, it is more usual to find references to agricultural damage and disaster valuation in researches that look globally at valuation. We can quote Vidal *et al.* (2000), Alonso and Serrano (2007) or Caballer (1999, 2008).

Specific research about agricultural insurances in the cattle sector is less common. The most significant are González *et al.* (1990, 1991), Pérez-Salas (2003, 2005) and Segura and Pérez-Salas (2005).

Finally, market or price risks must be underlined in the huge variety of risks that farms face. Several authors have looked at the problems and viability of farm income insurances as a viable alternative. We can quote Goodwin (2001), Just and Pope (2002), Pérez-Salas (2002b), Bielza (2004), Bielza *et al.* (2002, 2007a,b), Estavillo *et al.* (2005) and Aguado and Garrido (2007).

The valuation of damages

Damage can be considered, in its broadest sense, as the fact that produces a decrease in the value or the output that any economic good can generate. The basis for the damage valuation will be to establish the amount of value or output decrease regarding the value of the economic good. Its objective is to determine the indemnification that the owner of the damaged good should receive. Obviously, equilibrium has to be maintained between data objectivity and indemnification calculation fairness.

The fundamental situation of damage valuation in agriculture is linked to disaster evaluation in agricultural insurances. The expert can evaluate by applying several asset valuation methods (mainly harvest valuation methods) but there are some regulations regarding agricultural insurances. So, there is an administrative procedure that regulates the behaviour of the affected parts and agents[1] (Segura *et al*., 2000).

The following information is required in order to get a correct evaluation of the disasters that are covered by the insurance: 1) insurance special conditions, 2) land inspection sheets, to be filled with evaluation data, 3) specific rules about production damage evaluation and 4) the book of insurance cost of prime fares, edited by Agroseguro (2007), where the primes depending on areas (that correspond to each Autonomous Community and insurance crop line in each town) can be found.

The procedure for disaster appraisal in the farm is not going to be explained in depth (Segura *et al.,* 2000; Agroseguro, 2007; or ENESA, 2007 can be consulted for this). We will look at the definitive appraisal phase for citrus farms which has the purpose of determining the damage valuation. So, we previously need:

— The percentage of damage, both in quality and quantity.

— The real estimated production: it is the production that would have been obtained in the damaged farm if the disaster had not happened, during the insurance warranty period and according to the requirements that official marketing rules fix.

— The real final production: it is the production that can be harvested.

The definitive appraisal must be done prior to harvest and near to this date. If it is not possible to do so, the appraisal must be done on samples and it has to be indicated in the land sheet.

The damage evaluation and the calculation of the real estimated and the real final production have to be done on citrus trees that represent the damaged farm accurately. If no witness samples are maintained according to the Appraisal General Rules, the right to the indemnification will be lost.

The methodology for appraisal is as follows: the expert will go through the farm in order to see the disaster features and the farm production structure. Then, a minimum of three representative trees (free formation) and another six representative trees (directed formation) will be chosen. Finally, the damage is evaluated both in quantity and quality. The harvest must also be estimated (Agroseguro, 2007).

The quantity of damage will be identified as the difference between the final estimated production and the real final production of the farm. The quantity of damage percentage will be calculated relating to the real estimated production when all the sample trees were analysed. The expert will collect all the fruits of the tree or a significant quantity of fruits from each part of the tree in order to calculate the quality of damage. This is due to the fact that weather may not affect all the parts of the tree in the same way.

Then, the fruits are classified according to damage symptoms and intensity applying the tables of rates that are established in the Appraisal Specific Rules for each crop. Finally, the result obtained from the samples is spread out to all the production. Then, the expert can evaluate the damage.

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[1] The general rule for damages appraisal on agricultural production, protected by combined agricultural insurance was approved by Order 21st July 1986. (BOE 31st July 1986), as a compulsory development of the point 12 of the Law 87/1978 of 28th December of Combined Agricultural Insurances. Its contents fulfil the requirements of this Law; of the Regulation that develops it, approved by the Royal Decree 2329/1979, 14th September; of the Law 50/1980, 8th October, about Insurance Contracts, and the General Conditions of Agricultural Insurances. Moreover, it also has to be applied the corresponding Special Conditions for each Agricultural Insurances lines included in the Annual Plan of Combined Agricultural Insurances.

Material and methods

The area of citrus fruit trees in Spain is around 311,627 hectares. This represents 1.8% of all the Spanish cultivated land. Furthermore the Spanish citrus sector represents 10% of the final vegetal production. This production represents 50% of the sector exports in the European Union. Seven million tonnes were produced in 2006 of which 49.5% were oranges, 36.5% were tangerines and 12.8% were lemons. Comunidad Valenciana controlled 62% of the production in 2006, Andalucía 22% and Murcia 11% (MARM, 2008).

The evolution of citrus insurance contracts since 1998 until 2006 (Table 1) and the evolution of the global citrus insurance in the period 2001-2006 (Table 2) reflects the importance of citrus insurances related to the global amount of agricultural insurances. It has to be mentioned that there are more than 44,000 contracts. They represent 15% of ENESA subventions.

The insurance contract evolution can be analysed through the behaviour of several indicators: number of contracts, insured areas, insured capitals, etc. Possibly the behaviour of insured production in recent years permits more objective conclusions being obtained about insurance evolution.

Table 1 shows how insured production has increased year by year. The insured production goes from 1,700,000 tonnes in 1998 to more than 3,000,000 tonnes in 2006. The insured area was 100,000 ha in 2001 and more than 220,000 ha in 2006. Several facts could explain the insurance evolution in this sector: i) the inclusion of multi-crop policy to insurance plans in 1998; ii) the warranty extension for hailstorm risk that was included in the conditions of the corresponding insurances lines in 2001; iii) the weather instability in 2003, with strong frosts that affected all the Spanish southwest.

Table 1. Evolution of citrus insurance contracts in Spain in the period 1998-2006

Plan	No. of policies	Value of production (M€)	Ensured production (tonnes)
1998	36,609	472.99	1,777,654
1999	34,628	490.48	1,830,247
2000	35,724	517.72	1,898,586
2001	37,992	572.21	2,141,902
2002	41,542	670.89	2,440,085
2003	44,914	716.55	2,734,532
2004	43,926	690.19	2,536,593
2005	39,728	627.70	2,232,735
2006	44,630	806.26	3,004,148

Source: Agroseguro (2007).

The chosen line for this research is «Multicultivo de Cítricos y Complementario» (Citrus Multi-crop and Complementary, code 096), with all the options that it holds (orange, lemon, tangerine and grapefruit trees). This line intends to simplify insurance management because it allows contracting for the combination of several citrus productions in a sole policy for the entire production. «Multicultivo» line represents approximately 60% of the insured production. Its contract benefits from several additional subventions.

Once the line has been chosen, the next step is to locate the working areas (control plots). The main producing provinces are integrated in Spanish Levante (Valencia and Castellón) and Southwest (Alicante, Murcia and Almeria) according to Territorial Directions of Agroseguro (2007).

Citrus «Multicultivo» policy guarantees and insures productions relative to orange, tangerine (and their hybrids), lemon and grapefruit for risks of frost, hailstorm, wind, flood and exceptional damage. The election of the working areas has to take into account

Table 2. Evolution of the global citrus insurance in the period 2001-2006

Concept	2001	2002	2003	2004	2005	2006
Number of policies	37,992	41,542	44,915	43,926	39,728	44,630
	(12.71%)	(13.97%)	(16.14%)	(14.88%)	(13.81%)	(15.92%)
Ensured area (ha)	108,993	146,844	150,321	191,033	206,010	224,102
% ensured area/cultivated area	41.83%	56.35%	55.62%	70.68%	76.23%	82.92%
Production that could be ensured (tonnes)	5,537,500	5,750,000	6,261,800	5,902,300	5,411,000	6,446,100
Ensured production (tonnes)	2,141,902	2,440,085	2,731,873	2,536,593	2,232,735	3,004,148
% ensured production/production that could be ensured	38.68%	42.44%	43.63%	42.98%	41.26%	46.60%

( ): percentage related to all the policies. *Source:* Agroseguro (2007).

the existence of these crops with the several risks aforementioned. Spanish Southwest area (Alicante, Murcia and Almería) is one the most suitable area for these requirements.

The Autonomous Community Región de Murcia presents these varieties of crops. It is situated in the centre of the area VIII of the Spanish Committee of Agricultural Insurances (Agrupación Española de Seguros Agrarios) (Alicante, Murcia and Almería). So, results can be extended to all the area, that is to say, the Spanish citrus main producing area.

Murcia holds another advantage. It has a frost area distribution for citrus «Multicultivo and Complementario» that divides the region into several agricultural and appraisal areas.

The research population holds all the plots that are insured for citrus combined insurance in the Región of Murcia during the 2002-2006 period. It is never less[2] than 5,000 plots per year. The sample is 418 plots analysed over five years. This represents an error less than 5% for a level of confidence of 95.5%. The most representative areas of the Región for citrus production are Vega Media (Huerta de Murcia) and Campo de Cartagena, in San Javier area. The plots are situated as follows: Centre Area (lemon), 215 plots; South Area (lemon), 102 plots; North Area (orange, tangerine and lemon), 101 plots (orange, 47 plots; tangerine, 34 plots and lemon, 20 plots).

Analysis of the real risk and insurance premium settlement policy

As has been said, weather adversities are especially relevant in Spain. Most weather risks that normally affect agriculture exist in Spain. Almost 80% of more than 400,000 registered disasters in agricultural insurances during the 2001-2005 period came from risks derived from hailstorm, frost or drought. So, it can be said that there is an accident rate concentration due to these three risks. However, other risks such as wind, rain and flood are also important in Spain. The behaviour of these risks, both in time and space, is very irregular. Some researches (Ikerfel, 2006) estimate that 90% of Spanish producers, regardless of their producing activity, have faced disasters on some occasions. Two thirds of them were in the last two analysed years.

As it has been indicated, the objective of this paper is to find if there is a relationship amongst the rate and the insurance premium applied by insurance companies to insurance holder (farmer), the real risk level that the insured farms have to face due to any of the damages that are in the insured risks, and the relation of the previous variables with the indemnification received by the farmer after the damage valuation process.

It has to be said that the rate is a fixed quantity that the insurance company establishes yearly according to three factors: 1) town (citrus zones in Murcia); 2) crop (orange, tangerine and lemon); 3) ensured option (frost, hailstorm, wind, etc.).

The total cost (raw cost) of the insurance premium is obtained by multiplying the year rate by the kilograms of the ensured crop and its price. Then, the Agroseguro bonus is applied over the raw cost for obtaining the Base Net Cost of the insurance premium. The final insurance premium that the farmer has to pay is obtained after subtracting the subventions from ENESA and the Autonomous Communities from the Base Net Cost.

The relation between the final real production and the insured production has been considered as the indicator of the real risk in this paper. Values below one indicate the existence of a real risk level.

Finally, it has to be said that the final indemnity that farmers get in case of disaster is obtained after applying the damages both in quantity and quality to the production considered as base by the expert. A percentage has to be subtracted due to the fruits that can be used in the food transforming industry. Another percentage is subtracted due to the exemption considered in the insurance policy.

The real average risk for the five years, the average applied rate and the average indemnification received by farmers is going to be calculated for each of the 418 analysed plots. The objective is to see if there is a real relation among these variables or if an alternative system could be proposed.

Results

A statistical analysis has been done for these variables. The objective was to check the existence of a real relation among the risk that the plots support, the insurance premium that the farmers pay (with the rate that the

[2] The ensured plots were 5,591 (589 policies) in 2004, 6,081 plots (623 policies) in 2005 and 6,248 plots (576 policies) in 2006. No confident data were available for the other years.

Table 3. Statistics of the analysed variables

	Real risk	Indemnity	Rate	Insurance premium
Average	0.942	364.707	0.102	616.777
Average typical error	0.003	35.139	0.001	44.317
Median	0.936	166.495	0.093	288.402
Mode	1.000	0.000	0.093	232.431
Typical deviation	0.0542	718.411	0.022	906.055
Variance	0.003	516,114.241	0.000	820,936.141
Asymmetry	–0.777	5.437	3.830	3.195
Asymmetry typical error	0.119	0.119	0.119	0.119
Curtosis	0.954	38.674	23.643	11.334
Curtosis typical error	0.238	0.238	0.238	0.238
Range	0.266	6,757.039	0.202	6,320.087
Minimum	0.734	0.000	0.072	7.912
Maximum	1.000	6,757.039	0.274	6,327.998

insuring companies apply when they calculate the insurance premium), and with the indemnity that the farmers obtain from the insuring companies if there is a disaster. These statistics have been obtained from the average values of the different variables during the period (Table 3). The average real risk of a disaster in these plots during the five years of the research (which is calculated as the relation between the final real production and the insured production; so 1 indicates no risk) is 5.8%. The average indemnification got by farmers is €364.7. The average insurance premium paid by farmers has been €616.8 (the average rate is 0.102).

The relation among the variables will be analysed through the calculation of the bi-variate correlations among the variables from the correlation coefficient of Spearman (rho of Spearman) (Table 4).

Table 4 shows how the indemnification is correlated with the real risk. This is quite logical. There is a negative value due to the scale for data processing (1 = no real risk, 0 = total risk, all the production has been damaged). The rate and the insurance premium also show a significant correlation with the real risk. However, it is much lower than the indemnity one (especially the rate). The indemnity also shows a significant correlation with the insurance premium, but it does not show it with the rate.

Table 4. Bi-variate correlation coefficients among the analysed variables (Rho of Spearman)

	Real risk	Indemnity	Rate	Insurance premium
Real risk	1.000	–0.666*	0.157**	0.294*
Indemnification	–0.666*	1.000	–0.047	0.238*
Rate	0.157*	–0.047	1.000	0.086
Insurance premium	0.294*	0.238*	0.086	1.000

*,**: the correlation is significant at level 0.01 and 0.05 (bilateral), respectively.

Several regression analyses have been done in order to extend the relation among these variables. Firstly, we look at the relation between the rates used by insurance companies to calculate the insurance premium that farmers pay and the plot real risk.

As it has been said, 418 plots were analysed during five years. The average values of the variables during these five years have been used for calculations. Table 5 shows how the correlation coefficients of the several regressions are close to zero. This indicates no relation between the real risk and the rate that insurances companies use. The graphical representation shows how the rate is almost a constant, with no relation to the risk of suffering damage (Fig. 1).

The same result can be seen if we look at the relation between the insurance premium and the real risk. That is to say, there is no relation between the paid insurance

Table 5. Summary of the model and parameter estimations. Rate = f (Risk)

Equation	Summary of the model			Parameter estimations			
	R^2	F	Sig.	Constant	b1	b2	b3
Linear	0.047	20.560	0.000	0.018	0.089		
Logarithm	0.046	20.118	0.000	0.107	0.081		
Cuadratic	0.049	10.631	0.000	0.188	–0.282	0.202	
Cubic	0.049	10.626	0.000	0.136	–0.103	0.000	0.075
Potency	0.052	22.890	0.000	0.104	0.672		
Exponential	0.053	23.296	0.000	0.050	0.740		

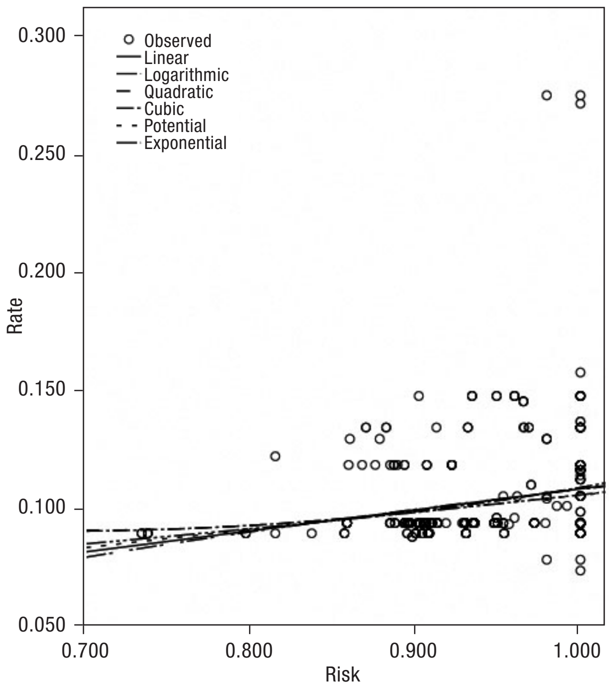

Figure 1. Relation between the rate and the real risk.

premium and the real risk of the plots (Table 6). This seems quite logical the main basis for the calculation of the insurance premium is the rate.

Finally, the relation between the indemnity and the real risk has been checked. No relation was found although R^2 were slightly higher (Table 7).

Discussion

As has been said, the insurance premiums settlement policy that insurance companies apply has no relation to the key element that should configure an insurance contract: the risk of disaster.

The insurance premium that insurance companies apply is calculated from a rate that companies establish yearly. This rate has even remained constant in some years. This rate should fundamentally take into account the risk of disaster. This rate, as it has been indicated, is calculated considering the town where the plot is situated and the insured crop and variety. So, these three variables should contain, or at least consider, the risk of disaster component of each plot. However, as it has been checked, the rate, in the way it is calculated now, does not consider the real risk. Furthermore, the three variables do not contain the existence of this risk.

It seems clear that the present system (that is to say, an almost constant relation between the rate and the real risk) guarantees neutral economic results to the insurance companies as a minimum. It does not take into account the probability that ensured plots have to present indemnifications due to damages. This system implies that a group of farmers (those with a lower real risk) is financing another group of farmers (those with a higher real risk) through over-valued insurance premiums (in the first case) and through insurance premiums that are under their theoretical value (in the second case).

Table 6. Summary of the model and parameter estimations.Insurance premium = f (Risk)

Equation	Summary of the model			Parameter estimations			
	R^2	F	Sig.	Constant	b1	b2	b3
Linear	0.014	5.924	0.015	–1,249.852	1,981.643		
Logarithm	0.013	5.612	0.018	725.469	1,767.254		
Cuadratic	0.017	3.681	0.026	8,709.661	–19,731.976	11,787.965	
Cubic	0.017	3.640	0.027	5,474.717	–9,012.617	0.000	4,303.115
Potency	0.080	36.355	0.000	432.754	6.613		
Exponential	0.086	39.291	0.000	0.251	7.482		

Table 7. Summary of the model and parameter estimations.Indemnity = f (Risk)

Equation	Summary of the model			Parameter estimations			
	R^2	F	Sig.	Constant	b1	b2	b3
Linear	0.148	72.502	0.000	5,176.631	–5,108.412		
Logarithm	0.150	73.238	0.000	75.696	–4,699.131		
Cuadratic	0.150	36.571	0.000	10,292.103	–16,261.107	6,054.614	
Cubic	0.150	36.571	0.000	10,292.103	–16,261.107	6,054.614	0.000

So, the present agricultural insurance system is not discriminative enough. It is clear that the calculation of the rate considering the three variables is not the fairest procedure. Insurance companies have enough data about all the variables to develop a more serious and close to risk reality analysis of each plot. By doing so, the rates could separate more efficiently farmers depending on their real risk level.

This could lead to a new area of research that could be developed in the future.

Acknowledgements

Thanks to Mr. Michael Matthews and Ms. Esther González for their comments and assistance in the preparation of this manuscript.

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