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## RESEARCH ARTICLE

# AGRICULTURAL INSURANCE AND AGRICULTURAL PERFORMANCE: GRANGER CAUSALITY TEST: AN APPLICATION IN ARGENTINA

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### ABSTRACT

In developed as in developing countries, the study of the impact of the development of the agricultural insurance on the agricultural performance is of a big utility as far as this study allows to pull measures of economic policies which allow to promote the agricultural insurance and the strategies allowing the country to pull the profits of the development of the agricultural insurance. We show the existence or not the causality between the agricultural performance and the development of the agricultural insurance and this by resorting to an econometric approach which defines itself as follows: by proceeding by a study of the stationarity of the series to determine their order integration. In the second stage, we test the existence of a relation of cointegration between the used variables. Afterward by specifying the parameters of the model, we make the tests of causality, decomposition of the variance and the tests of the distribution of residues. The Granger causality test was then used to make the various tests in Argentina. We found interesting results in this connection which reflect the state of the agricultural insurance and the implications of its use to allow the preservation of the agricultural performance. Besides, we showed in term of causality the implications of the application of the agricultural modalities of risk management on the agricultural performance. By applying all of the tests, we show the existence of a causality between the agricultural performance and the development of the agricultural insurance which is measured by the penetration in the agricultural insurance. And this causality is valid for Argentina between 2000-2012. It's a unidirectional causality which remains true in the short and long term so we can adopt the model estimated for projected effects. In this result is added a causality which puts in relation the action of the State by direct helps granted to the insurants in the form of subsidies of the premiums of agricultural insurance and their effects on the agricultural performance.

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## INTRODUCTION

The evaluation of the interaction between the potential activity of the market of the agricultural insurance and the agricultural performance is of a big importance to be able to estimate the degree of contribution of such activity at the agricultural activity. The agricultural production is affected by several types of risks among whom the natural risks due to climate change, to drought, to hail, to floods, risks of production likened to the risks of yield. It is also submitted to the degree of the development of the agricultural activity among which the economic, social and demographic factors which affect it. We shall test the hypothesis which stipulates that the agricultural insurance could have a positive impact on the agricultural performance as far as the insurance

has a stabilizing effect on income in sight that compensations are paid in case of losses of the insurants. The fact of having a stable income allows to have guaranteed loans, it is about a condition fixed by the financial authorities to grant loans to the farmers. And to promote agricultural investments is a necessary condition to insure a real growth of the agricultural production and an improvement of the agricultural productivity. Besides, certain activities of production are too much risked without the appeal to the insurance. In consequent, the administrators of farms target the management of agricultural risks by joining certain insurance contracts. The economic performance of farms is supposed to be influenced by explanatory variables such as the characteristics of the agricultural management; the characteristics were connected to the production and the characteristics of the farm.

We wait for in the fact that the sign of the impact of these variables depends on the performance indicator of the agriculture. The characteristics connected to the production are

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expressed by the following variables such as the agricultural investment, the protection of the cultures, the subsidies, the agricultural spending and the quality of lands or grounds. Through the empirical analysis which we make we identify on one side, the impact of the various explanatory factors of the development of the agricultural insurance on the real growth of the agricultural production and on the other hand, the effects of the development of the activity of agricultural insurance on the agricultural productivity.

Aiming at showing the existence or not of causality between the agricultural insurance and the agricultural performance, we choose Argentina as representative country of the American countries. The choice of this country was made on the basis of their strong penetration in the agricultural insurance during period 2000-2012 according to the statistics of the International Observatory of the Agricultural Insurance. We would show the existence or not of a causality between the agricultural insurance and the agricultural performance in Argentina by applying the econometric method to know the Granger causality test.

In Argentina, the agrarian sector is one of the sectors the most threatened by the rains of hail. Because of the global warming, these last years, these rains would become more frequent and more intense. It is what to let develop the private insurances to face risks. The insurance is intended in particular for the Soya which is strongly exported and which establishes the majority of the yields on the Argentine farmers. The Soya is so the main assured culture. Argentina displays on the first place of the Latin American countries being more than 60 % of its lands. The agricultural insurance sector underwent heavy losses in 2010 and 2011 further to a succession of natural disasters. It is the reason why the volumes of the premiums of agricultural insurance increased considerably during this period.

We target to show the causality between agricultural insurance and the agricultural productivity on one hand and the causality between the development of the agricultural insurance and the real growth of the agricultural production on the other hand. In other words, we shall test the causality between agricultural insurance and agricultural performance. To be made, we use the technique of causality of Granger. The study is made on a country where the agricultural insurance is strongly developed in Argentina between 2000-2012. The choice of the country was made on the basis of the penetration rate in the agricultural insurance the highest among the countries of the sample in three continents. We use the following variables: the rate of real growth of the agricultural production, the agricultural productivity, the subsidies of the premiums of agricultural insurance, the premiums of agricultural insurance, the agricultural spending and the penetration in the agricultural insurance.

The study which we lead uses the theory of the cointegration of Engels and Granger to analyze the relation between the development of the agricultural insurance and the growth of the agricultural production on one hand and the agricultural productivity on the other hand in Argentina between 2000-2012. It allows to pull the observations and the teachings and to

deduct the implications on the causal relations between the aforesaid variables.

## Literature Review

Historically, the importance of the activity of insurance is not new because some references to the activity of insurance were mentioned in the works of Adam Smith, the Marshall Island and in that of Knight.

However, these works did not specify its contribution to the economic activity and did not really study its role and its modalities of management of risk. It was during 1960s when the economy of insurance knew its peak with the works of Borsh (1962) and Arrow (1970) which showed that it is the theory of insurance that allows the economic analysis of the risk and the uncertainty. Laguerre (1990) supposed that " No society can prosper without mechanisms of risk coverage ". According to Grace and Rebello, (1993), the activity of the insurance can contribute on the activity of the banking sector. The development of the activity of insurance could encourage the bank loan by increasing the demand of financial services.

The evaluation of the relation between the potential activity of the market of the insurance and the economic growth was presented by Ward and Zurbruegg (2000), Webb and al. (2002) Kugler and Ofoghi (2006), and Adams, Andersson, and Lindmark (2006) for the countries of the OECD, it was Ward and Zurbruegg (2000) which tried to explain the potential relation between the growth of the insurance sector and the economic growth. These authors used the tests of cointegration of Johansen to explain the models of test and correction of errors to explain the relation of causality between the economic growth and the insurance. They examined the relation of potential causality between the economic growth and the activity of the market of the insurance for the countries of the Organization of the Trade and the Economic development for period 1961-1996 and this by using the annual Real Gross domestic product as measure of the economic growth and the annual premiums as the measure of the insurance. According to Beck and Webb (2003), as financial service, the insurance is considered as a particular service which affects the economic growth. Chun-Ping (2005) explained the relation enter the development of the market of the insurance (via the penetration and the density) and the economic growth. The variables which are used are relative to the demography, to the financial level in the economic profit and in the regional conditions. Kugler and Ofoghi (2006) showed proofs of long-term causality of the insurance in the growth of the Gross Domestic Product for eight categories of insurance in the United Kingdom. Marco. In (2006) showed that in the developed countries or in the developing countries, the activity of insurance is considered as a financial intermediary and a supplier of transfer of risk. Such an activity allows insuring the compensation of the insureds what could contribute to the economic growth by allowing managing the risks in an effective way. Arena (2008) found proofs of a link of causality enter the development of the insurance on the economic growth a wide panel of 56 countries and of 28 years (1976-2004). Curak, Loncar and Poposki (2009) examined the relation between the development of the agricultural insurance sector and the economic growth in ten

countries member states of the United States enters the period 1992-2007.

Besides, Olubiyo and Ajfand (2009) tried to make a comparison between the practices of production between the insured and uninsured farmers by using an econometric analysis and this by referring to functions of which integrates the option agricultural insurance. The results showed that the insured farmers are directed to the choice of the combination of the factors of production such as inputs what cause an increase of the production.

One of the underlying hypotheses of the agricultural insurance, it is because its introduction allows to encourage the farmers to change positively the agricultural practices what allows to increase the production further to an effective use of the agricultural inputs. The analysis suggests that the insured farmer would generate more power and a net profit by reducing their current level of the use of the resources compared with the uninsured farmers.

Most of the empirical studies which targeted the evaluation of the interaction between the activity of insurance and the economic growth were based on descriptive analyses to analyze the development of the activity of insurance and its effect on the economic activity. On the other hand, concerning the agricultural activity, the activity strongly subjected to the risks that are natural risk or risk of production which is of for the variability of the agricultural yields, the empirical studies were rare. Our work tries to show empirically if there is causality between the development of the agricultural insurance and the agricultural performance for one of the American countries, namely Argentina during period 2000-2012.

## Econometric Issues

### Model specifications

We specify the model, the sources of the data and our methodological approach and we analyze the stationarity of the series to be able to determine the level of integration of variables. It is a question of identifying the explained variable and the explanatory variables of the model, the signs of the parameters and the equation of the model. Our analysis joins in the theoretical frame of the approach of the institutional adaptation developed by Wilhelms (1998); this approach supposes that the agricultural performance depends on institutional variables and on adopted policies of regulation; in fact, the approach of the institutional adaptation grants an important role to the State in its regulation besides the role of the market.

The agricultural performance is estimated by the rate of real growth of the agricultural production (according to the FAO) and by the global agricultural productivity of factors. The variables of the model were specified in the methodology of analysis and both estimated models will be of type

$$VPA = \beta_0 + \beta_1 \text{penetration} + \beta_2 \text{AgrinsurSubsidi} + \beta_3 \text{Prim} + \beta_4 \text{Agricultural spending} + \varepsilon_t \quad (1)$$

$$PGFA = \beta_0 + \beta_1 \text{penetration} + \beta_2 \text{Agr insu Subsidi} + \beta_3 \text{Pr im} + \beta_4 \text{agricu spending} + \varepsilon_t \quad (2)$$

With

The rate of real growth of the agricultural production, noted VPA.

The global agricultural productivity of factors, noted PGFA.

VPA and PGFA measure the agricultural performance of the country.

The penetration rate in the agricultural insurance, Penetration (Noted in the Table Ser)

Subsidies of the premiums of agricultural insurance. Agri. ins subsidi, (noted in table SAA)

The premiums of agricultural insurance, noted Prim.

The agricultural spending other than the subsidies of production prices, noted agricu spending (noted in table DPA)

$\beta_0$  is a constant

$\beta_1, \beta_2, \beta_3$  and  $\beta_4$  are the coefficients relative to every variable

and  $\varepsilon_t$  is the term of error.

## Data and results

The data cover the period 2000-2012 and result from the FAO and the publications of the statistics of the American Ministry of Agriculture. The software used for the estimation is Eviews 8. Variables are taken in real terms.

This study on the impact of the agricultural insurance on the agricultural performance in Argentina has for objective to analyze the impact of development of the agricultural insurance on the growth of the agricultural production and on the agricultural productivity in Argentina, to determine the measures of agricultural risk management policies susceptible to minimize the agricultural risks allowing Argentina and farmers assured to maintain stable their agricultural production and them returned. So the Econometric methodology that we adopt comes true in four stages. The first stage consists of the study of the stationarity of the series to determine their orders of integration. The second stage tests the existence of a relation of cointegration between the used variables. The third stage is interested in the estimation of the parameters of the model and the last and fourth stage allows making the test of causality.

We identify before preceding in these test the descriptive and explanatory analyses of the evolution of the agricultural insurance and its determiners in Argentina. The endogenous variable is the rate of real growth of the annual agricultural production of the country or the agricultural productivity of the country in the period 2000-2012. The explanatory variables are the subsidies of the premiums of agricultural insurance, the premiums of agricultural insurance, the agricultural spending and the penetration in the agricultural insurance. The model allows making the various tests: stationarity and causality. By making these tests, the results relative to the American

Economy obtained about the interaction between agricultural insurance and agricultural performance are interesting. The test of stationarity revealed that all the variables are still in first difference and they are quite significant. The model is globally significant and can be used for the forecast.

### The granger causality: Case of the Argentina

#### Tests of integration and stationarity of the series

We target as for two other countries, to define and to show the existence or not of causality between agricultural insurance and agricultural performance for the Argentina, one of the American countries which is characterized by the development of the industry of agricultural insurance. We shall adopt the same econometric approach by opting for the use of the granger causality test.

Thus, we make the various tests to be able to define a model which has a predictive effect of the causality. The variables are retained, and the same period of study. By both tests of stationarity of Dickey Fuller (ADF) and test of Philips-Perron (PP), we show the stationarity of the used series.

The following Tables present the results of the tests of stationarity.

We shall opt for the test of causality of Granger as far as all the variables according to the results of the test of Unitarian root of Dickey-Fuller Augmente (ADF) and that of Philips-Perron all the used variables are still in first difference and because all the variables are integrated by the same order.

**Table. Results of the tests of integration and stationarity of variables**

Test of stationarity (at the threshold of 5 %)								
Variables	Stationarity		Dickey-Fuller (ADF)		Philips-Perron		Stationarity	
	Yes/ No	Order of integration	Value of the statistics	Critical value	Value of the statistics	Critical value	Yes/ No	Order of integration
VPA	Yes	I(1)	-4.012	-1.977	-4.099	-1.977	Yes	I(1)
PGFA	Yes	I(1)	-6.502	-1.982	-8.798	-1.977	Yes	I(1)
SAA	Yes	I(1)	-4.012	-1.977	-4.099	-1.977	Yes	I(1)
PRIM	Yes	I(1)	-3.519	-1.977	-3.662	-1.977	Yes	I(1)
PENET	Yes	I(1)	-3.162	-1.977	-3.313	-1.977	Yes	I(1)
DPA	Yes	I(1)	-2.399	-1.977	-2.399	-1.977	Yes	I(1)

Source : the Author from the data of the model

**Table. Test of Causality of Granger**

Pairwise Granger Causality Tests			
Sample: 2000 2012			
Lags: 2			
Null Hypothesis:			
SER01 does not Granger Cause VPA	Obs	F-Statistic	Prob.
VPA does not Granger Cause SER01	11	2.81787	0.1371
DPA does not Granger Cause VPA	11	1.03465	0.4111
VPA does not Granger Cause DPA	11	0.15246	0.8618
PRIM does not Granger Cause VPA	11	6.23802	0.0342
VPA does not Granger Cause PRIM	11	1.81476	0.2419
SAA does not Granger Cause VPA	11	1.08280	0.3967
VPA does not Granger Cause SAA	11	NA	NA
PGFA does not Granger Cause VPA	11	2.08608	0.2052
VPA does not Granger Cause PGFA	11	0.21900	0.8095
DPA does not Granger Cause SER01	11	3.51464	0.0977
SER01 does not Granger Cause DPA	11	0.50086	0.6293
PRIM does not Granger Cause SER01	11	1.36615	0.3244
SER01 does not Granger Cause PRIM	11	1.14514	0.3791
SAA does not Granger Cause SER01	11	1.03465	0.4111
SER01 does not Granger Cause SAA	11	2.81787	0.1371
PGFA does not Granger Cause SER01	11	7.42360	0.0238
SER01 does not Granger Cause PGFA	11	1.73575	0.2542
PRIM does not Granger Cause DPA	11	0.02871	0.9718
DPA does not Granger Cause PRIM	11	1.93693	0.2244
SAA does not Granger Cause DPA	11	6.23802	0.0342
DPA does not Granger Cause SAA	11	0.15246	0.8618
PGFA does not Granger Cause DPA	11	0.16911	0.8483
DPA does not Granger Cause PGFA	11	1.18025	0.3696
SAA does not Granger Cause PRIM	11	1.08280	0.3967
PRIM does not Granger Cause SAA	11	1.81476	0.2419
PGFA does not Granger Cause PRIM	11	5.32726	0.0468
PRIM does not Granger Cause PGFA	11	1.14412	0.3794
PGFA does not Granger Cause SAA	11	2.08608	0.2052
SAA does not Granger Cause PGFA	11	0.21900	0.8095

Source: the Author from the data of the model

## Test of causality

By the Granger causality test, we were able to demonstrate following unidirectional causalities between:

1. The growth of the agricultural production and the agricultural spending.
2. The agricultural spending and the penetration in the agricultural insurance.
3. The agricultural productivity and the penetration in the agricultural insurance.
4. The subsidies of the premiums of agricultural insurance and the agricultural spending.
5. The agricultural productivity and the premiums of agricultural insurance.

Variables relative to these causalities are cointegrated at the threshold of 5 %.

As a matter of fact, according to the results of the Table 1, in short or long-term the real growth of the agricultural production causes the development of the agricultural insurance because the  $p$  – value is lower than 5 %, that is the previous information on the rate of real growth of the agricultural production allows a better forecast of the level of the development of the agricultural insurance, measured by the penetration in the agricultural insurance. Thus, the results of the test allow to reject the no hypothesis and to conclude the existence of causality between the agricultural productivity and the penetration in the agricultural insurance. It emerges from Table 2 the causalities which translate relations in short or long-term between. Besides, we conclude the existence of a relation of causality between the premiums of agricultural insurance and the agricultural productivity. The relation of causality between the agricultural spending and the development of the agricultural insurance is shown by the test of causality and finally the causality between the agricultural spending and the subsidies of insurance premiums is demonstrated well.

It emerges from Table concerning the analysis in terms of global agricultural productivity of factors, explanatory causalities of the state of the Argentina agricultural market of insurance and of that of the agricultural activity in this country. In fact, in the short and long term the causality enters the penetration the agricultural insurance and the global agricultural productivity is based and justified in Argentina.

The causality between the insurance premiums and the agricultural productivity is also shown by Granger causality test. Also there is causalities between to the agricultural insurance subsidies and agricultural spending. This study targeted as main objective the demonstration of the existence or not the causality between the agricultural insurance and the agricultural performance in Argentina during period 2000-2012. The test of stationarity showed that all the used variables are stationnary in first difference and they are quite significant, where from the predictive effect of the model used for our estimation. It emerges from these results that in Argentina, the agricultural productivity causes the penetration in the agricultural insurance during period 2000-2012.

It supposes that the previous information on the agricultural productivity allows planning the development of the agricultural insurance in Argentina. The unidirectional causality between the agricultural spending and the penetration in the agricultural insurance is demonstrated in Argentina. This relation supposes that the development of the agricultural insurance depends on agricultural spending supplied by the State to the insurants other than the subsidies of the prices or the direct aids on the premiums of agricultural insurance; or as an example spending for infrastructure, for agricultural investments. A causality which confirms the interaction between the real and the financial sphere where evolves the agricultural activity. In fact, the agricultural productivity is dependant on volumes of the premiums of agricultural insurance in the economy. It means confirming the causality between the agricultural productivity and the penetration in the agricultural insurance where the penetration in the agricultural insurance is other than the relationship between the volumes of agricultural insurance reported to the value of the agricultural production. In Argentina, the subsidies of the premiums of agricultural insurance cause the agricultural spending.

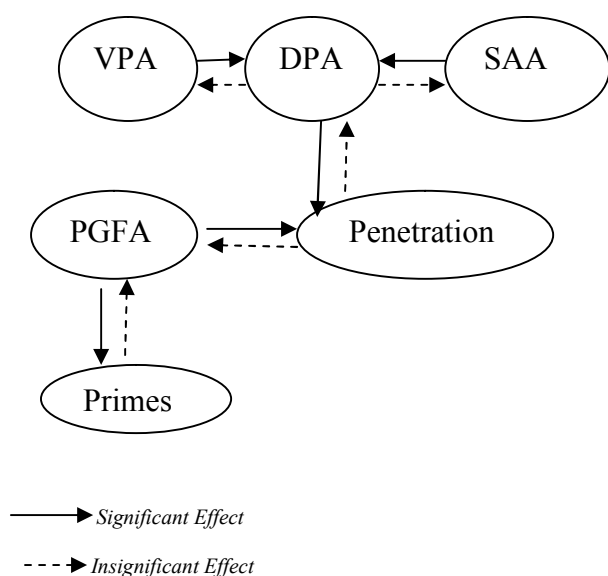
## Conclusions and Policy implications

Throughout our study, we targeted for main objective to study the impact of the development of the agricultural insurance, measured in term of penetration in the agricultural insurance on the agricultural performance in one representative American countries such us Argentina, during period 2000-2012. To do it, we used the Granger Causality Test. By these tests, we were able to make important results which reflect the reality of the agricultural activity in Argentina. For Argentina, the test of stationarity showed that all the variables are stationnary in first difference. The model used to estimate the impact of the agricultural insurance on the agricultural productivity is globally significant. The model is not autocorrelated, homoscedastic and follows a normal distribution, so it can be used for the forecast. From the study led on the Argentina economy concerning the existence or not of an interaction between the activity of agricultural insurance and the agricultural performance, we were able to clear three types of causalities (we schematize the causalities in Figure 1) namely:

**The first causality** demonstrates that the agricultural productivity causes the penetration in the agricultural insurance in Argentina. As a consequence, the analysis of the causality supplies us with previous information on the level of growth of the agricultural production and this for a forecast of the development of the agricultural insurance. Besides, the previous information on the agricultural productivity in Argentina allows preventing better the penetration in the agricultural insurance.

**The second Causality** is a unidirectional one between the agricultural productivity and the premiums of agricultural insurance. A causality which supposes that the development of the agricultural productivity depends on the development of the insurance agricultural.

**And the third Causality** presents the relation between the agricultural spending and the agricultural insurance subsidies.



Source: The Author from the data of the model

**Figure 1. The causalities by retaining the real growth of the agricultural production or the global agricultural productivity of factors**

VPA: The real growth of the agricultural production

Penetration: The rate of penetration on the agricultural insurance

PGFA: The global agricultural productivity of factors

DPA: Agricultural Subsidies

Subsidies: Subsidies of the agricultural premiums

Primes: Agricultural insurance premiums

It supposes that the growth of the agricultural production depends on the availability of the agricultural spending supplied by States, aids other than the subsidies of the agricultural price or the subsidies of the premiums of agricultural insurance.

The main policy implications arising from our study can be presented as follows. The development of agricultural insurance implies the promotion of agriculture performance. Yet, the development of the agricultural insurance supposes that the State intervenes in the management of agricultural risks by subsidizing the premiums of agricultural insurance, the volume of insurance premiums which will impact the industry of agricultural insurance. Besides, it is for the effective agricultural risk management policy and an agricultural development policy that comes true the durability of the agricultural insurance.

As a matter of fact, the development of agricultural insurance exerts a positive impact on agricultural performance in Argentina. Our analysis in terms of causality can be improved by integrating other data relative to the agricultural development, to the risk management policy agricultural and to the development of insurance activity.

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