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RESEARCH ARTICLE

AGRICULTURAL INSURANCE AND AGRICULTURAL PRODUCTIVITY: GRANGER CAUSALITY TEST: AN APPLICATION IN THE UNITED STATES

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ABSTRACT

This article tries to show the existence of the causality between the agricultural productivity and the development of the agricultural insurance and this by resorting to an econometric approach using Granger Causality Test. This econometric analysis is made over the period 2000-2012 for one of the American country to know the United States. 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 productivity. In United States as in the developed countries, the agricultural insurance acquires a big importance as far as it is used for a long time as one management tool of the agricultural risks. Through our econometric analysis, we try to show the existence or not of a causality between the agricultural productivity and the development of the agricultural insurance in the United States during period 2000-2012. To be made, we shall test the existence of a relation of cointegration between the variables which are used and we shall proceed by a study of the stationarity of the series to determine their orders of integration. By applying Granger causality test, we show the existence of an unidirectional causality between the development of the agricultural insurance and the agricultural productivity in the United States and we also identify the existence of an unidirectional causality enter the development of the agricultural insurance premiums to United States and the agricultural productivity enters the period 2000-2012. These two results confirm our working hypothesis which stipulates the existence of causality between the development of the agricultural insurance and the agricultural productivity in the United States.

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INTRODUCTION

The relation between insurance development and economic performance has been the subject of considerable academic research. Several other authors tried to show the importance of the insurance in the process of the economic development in particular in developing countries in spite of the difficulty seizing and including the degree of contribution of the insurance in the economic activity. Adam and al. (2005) examined empirically the relation between the banking activity, the insurance and the economic growth in Sweden for period 1830-1998 by using the tests of causality of Granger. The results showed that the banking development and not of the insurance (by the total insurance premiums) cause the economic growth in Sweden in XIX th of Century and that the insurance seems to be motivated by the rhythm of the growth of the economy. According to the World Bank via empirical works of Erik's and Rodney (2011), it was shown that there is a link of causality between the development of the insurance sector and the economic growth, although the results turn out sometimes ambiguous. Piece, (2012) showed that the development of the industry of the insurance assurance can contribute to the economic growth as a financial intermediary and a supplier of transfer of risks and compensation to manage the risks in an effective way. The insurance allows insuring the risk management to reduce the losses. Craig. M and Fotis (2013) were able to estimate the impact of the use of the insurance on the economic performance of farms by making an analysis of the determiners of the demand of the agricultural insurance, saw that the demand of the agricultural insurance could affect the agricultural performance and this by using a model in two simultaneous equations. The first equation describes the impact of the explanatory variables, including the use of the insurance, on the performance of the agricultural activity. And the second equation describes the impact of the explanatory variables, including the agricultural performance and the demand of the insurance.

Yesuf (2014) identified the insurance collect as an effective institutional mechanism to face the risks of production. It is estimated the impact of the insurance collects on the risks of production. Once used the insurance collects, it will affect the

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yields on the farmers. Mirela and Silviu (2014) tried to analyze the correlation between the insurance and the economic growth by showing the existence of a direct link of causality between both, such as the level of development of the insurance sector depends on the degree of economic development of the country. Various studies have focused on different countries, time periods, modeling techniques and different proxy variables which have been used for insurance activity such us rate of penetration on insurance.

The development of the insurance as an economic activity comes from the necessity of facing risks for a behavior of solidarity between the individuals. It is in this spirit that establishes themselves the institutions of insurance which have for principle to insure solidarity between the various individuals in case of risks. The role of insurance companies is to insure a behavior of mutual insurance between the various individuals to face the risks. And it is the World Bank through studies made for the years eighty that incited so that insurance companies play a role in the reduction of the risks by sharing the risks between the various individuals especially in case of grave risks. We suppose that the quantitative evaluation of the impact of the insurance in the economic activity is of a big importance to be able to encircle the factors which could contribute to the development of the activity of insurance and as a consequence that could impact on the economic activity. Our work joins from this perspective; it is supposed that the management of agricultural risks by the agricultural insurance could have a significant impact on the growth of the agricultural production and on the agricultural productivity.

We shall move forward empirical models which allow estimating the effects of the development of the penetration at the agricultural insurance on the growth of the agricultural production on one hand and on the agricultural productivity on the other hand. From the existing studies, we can use the Granger causality test to study the causality between agricultural insurance development and agricultural performance. The objective of this study is to show the causality between agricultural insurance and the agricultural productivity. To be made, we use the technique of causality of Granger. The study is made on United-States, a country where the agricultural insurance is strongly developed between 2000-2012. United-States will be the representative country on which is made our test of Granger. The choice of this country was made on the basis of the penetration rate in the agricultural insurance the highest among the countries of the sample in American countries. 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 agricultural productivity in the United States 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. In this article we present in section 2 briefly reviews the related literature, followed by section 3 that present the econometric modeling approach and describe the data used, section 4 depicts the empirical findings and the final section, section 5, holds the concluding annotations and presents some policy implications.

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. K (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, 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 insurants 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 10 countries member states of the EU enters the period 1992-2007.

Olubiyo and Ajfand. O (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 integrate 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 led to 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 productivity for one of the American countries, namely United-States 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) and who finds his origin in the school of the integration. 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 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:

In terms of global agricultural productivity of factors (PGFA)

$$PGFA = \beta_0 + \beta_1\ penetration + \beta_2\ Agr\ insu Subsidi + \beta_3 \Pr im + \beta_4\ agricuspending + \varepsilon_t \qquad (1)$$

With PGFA: the global agricultural productivity of factors, which measures the agricultural performance of the country.
Penetration: The penetration rate in the agricultural insurance (SER)

Agr Insu Subsidi: Subsidies of the premiums of agricultural insurance (SAA)

Prim: The premiums of agricultural insurance (PRIM)

Agri Spending: The agricultural spending other than the subsidies of production prices (DPA)

β_0 is a constant

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

ε_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 USDA (Agricultural Division of the United States). 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 productivity 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 United States, to determine the measures of agricultural risk management policies susceptible to minimize the agricultural risks allowing United States 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 United States. 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 test in United States

Tests of integration and stationarity of the series

A series is said stationary if it does not contain either trend, or seasonality. More generally no factor evolves in time. To test the stationarity of a series, we make the test of stationarity of Dickey Fuller (ADF) and the test of Philips-Perron (PP). The test ADF takes into account only the presence of autocorrelations in the series, the test of PP consider in more the hypothesis of presence of autocorrelation, a dimension of heteroscedasticity in the series. We make the test of stationarity and the test of causality to answer the objective of our study to know how to show the existence or not of causality between the agricultural insurance and the agricultural performance, expressed in terms of real growth of the agricultural production and the agricultural productivity.

The results suppose that in the United States the agricultural productivity is dependant on the development of the agricultural insurance, measured by the penetration in the agricultural insurance.

In fact, the premiums of agricultural insurance affect the development of the agricultural insurance in a country once developed these premiums impact the agricultural productivity.

Interpretations of the results of the estimation in the United States

As a matter of fact, according to the results of the Table, in short or long-term the agricultural productivity causes the development of the agricultural insurance because the p-Value is lower than 5 %, that is the previous information on the agricultural productivity allows a better forecast of the level of the development of the agricultural insurance, measured by the penetration in the agricultural insurance.

Table 1. The results of the tests of stationarity

	Test of stationarity (At the threshold of 5 %)							
Variables	Stationnarity Yes/ No	Ordre of integration	Dickey-Fuller (ADF) Value of the statistics	Critical value	Philips-Perron Value of the statistics	Critical value	Stationnarity Yes/ No	Value of the statistics
PGFA	Yes	I(1)	-2.792	-1.977	-2.792	-1.977	Yes	I(1)
SAA	Yes	I(1)	-2.792	-1.977	-2.792	-1.977	Yes	I(1)
PRIM	Yes	I(1)	-2.792	-1.977	-2.792	-1.977	Yes	I(1)
PENET	Yes	I(1)	-2.520	-1.977	-2.792	-1.977	Yes	I(1)
DPA	Yes	I(1)	-2.816	-1.982	-2.792	-1.977	Yes	I(1)

Source: the Author from the data of the model

The results of the test of unitarian root of Dickey-Fuller Augmentee (ADF) and that of Philips-Perron show that all the used variables are still in first difference. And because all the variables are integrated by the same order, they can be cointegreted in the sense of Granger according to the econometric theory. We thus try to explain the causality to the sense of Granger between the agricultural insurance and the agricultural productivity in the United States during period 2000- 2012.

The test of causality

The notion of causality in the sense of Granger is a theoretical approach of the causality which defines in theory the causality (cause - effect) and in more presents a predictive character of the possible cause on the effect. In the sense of granger, a variable X causes a variable Y if and only if the past and present values of X allow predicting better the values of the variable Y. In other words, it will present a better prediction given a perfect knowledge of the past and present values of the variable X. The test of causality of Granger allows to examine if the value of Y is significantly connected to variables delayed the same variable and variables delayed of X which is the causal variable. We present the results of the test of causality to the sense of Granger by leading an analysis in terms of global agricultural productivity of factors for the United States.

Table 2. The results of the Granger Causality test

Pairwise Granger Causality Tests			
Sample: 2000 2012			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
PGFA does not Granger Cause DPA	11	2.07015	0.2072
DPA does not Granger Cause PGFA		1.87904	0.2325
PRIM does not Granger Cause DPA	11	0.47281	0.6446
DPA does not Granger Cause PRIM		0.09982	0.9065
SAA does not Granger Cause DPA	11	0.06903	0.9340
DPA does not Granger Cause SAA		0.13901	0.8729
SER01 does not Granger Cause DPA	11	0.35808	0.7130
DPA does not Granger Cause SER01		0.03338	0.9674
VPA does not Granger Cause DPA	11	0.33841	0.7257
DPA does not Granger Cause VPA		0.35557	0.7146
PRIM does not Granger Cause PGFA	11	7.70053	0.0220
PGFA does not Granger Cause PRIM		0.47011	0.6461
SAA does not Granger Cause PGFA	11	2.97528	0.1266
PGFA does not Granger Cause SAA		0.20978	0.8165
SER01 does not Granger Cause PGFA	11	4.56653	0.0623
PGFA does not Granger Cause SER01		0.39990	0.6870
VPA does not Granger Cause PGFA	11	3.74266	0.0881
PGFA does not Granger Cause VPA		0.09740	0.9086
SAA does not Granger Cause PRIM	11	1.26941	0.3469
PRIM does not Granger Cause SAA		1.16933	0.3725
SER01 does not Granger Cause PRIM	11	0.79606	0.4936
PRIM does not Granger Cause SER01		1.49969	0.2964
VPA does not Granger Cause PRIM	11	0.02525	0.9752
PRIM does not Granger Cause VPA		1.11654	0.3870
SER01 does not Granger Cause SAA	11	1.75265	0.2515
SAA does not Granger Cause SER01		1.95275	0.2222
VPA does not Granger Cause SAA	11	0.52384	0.6170
SAA does not Granger Cause VPA		0.27642	0.7677
VPA does not Granger Cause SER01	11	0.58213	0.5874
SER01 does not Granger Cause VPA		0.70542	0.5307

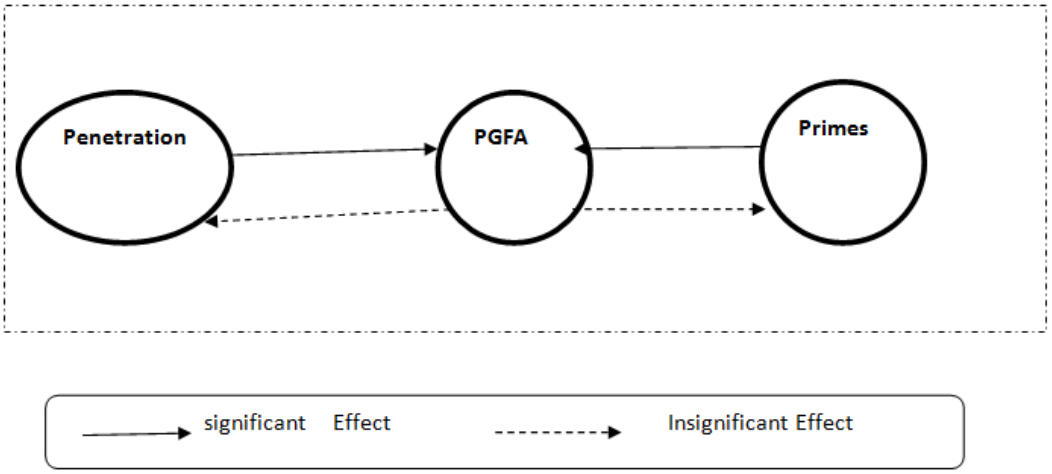
Source: The Author from the data of the model

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 same table of the causalities which translate relations in short or long-term between the premiums of agricultural insurance and the agricultural productivity in the United States during period 2000-2012. To this end we resorted to the model for our tests of stationarity and causality. From these tests, important results are found. (Results are schematized in Figure 1)

In the political plan, these results show that measures of development of the industry of agricultural insurance by the development of the premiums of agricultural insurance are translated by an improvement of the agricultural productivity, where from the necessity of promoting the service of

Penetration: The rate of penetration on the agricultural insurance

PGFA: The global agricultural productivity of factors



The test of stationarity showed that all the used variables are stationary in first difference and they are quite significant, where from the predictive effect of the model used for our estimation.

- The development of the agricultural insurance in the United States affects the agricultural productivity.
- In other words, the agricultural productivity depends on the development of the penetration in the agricultural insurance. A unidirectional causality demonstrated in the United States.
- And the second causality which puts in relation the premiums of agricultural insurance and the productivity In the United States during period 2000-2012.

Conclusion

This article attempted to analyze the relations of causality between the development of the agricultural insurance and the agricultural productivity in the United States between 2000-2012. This country constituted an excellent case for such an exercise as far as he allowed showing that the penetration to the market of the agricultural insurance is a determining factor which affects the agricultural productivity of the country. Through the tests of stationarity and the test of causality of Granger, the results showed that: The series of variables insurance premiums, penetration in the agricultural insurance, the agricultural productivity, the agricultural spending and the subsidies of the premiums of agricultural insurance are stationary in first difference. And the relation between the penetration in the agricultural insurance and the agricultural productivity is unidirectional. Besides, the relation between the premiums of agricultural insurance and the agricultural productivity is a unidirectional causality and not the opposite.

Primes: Agricultural insurance premiums agricultural insurance to allow the development of the farming sector and to benefit from effects of training of the regulation by the agricultural insurance. Because in the sense of Granger, the development of the agricultural insurance measured by the penetration in the agricultural insurance cause an improvement of the agricultural productivity, the American state will gain more if it will fix adequate measures directed to the development of the industry of agricultural insurance. To assure a volume of the premiums of considerable agricultural insurance allows developing the activity of agricultural insurance what would contribute positively to the agricultural productivity. The sector of agricultural insurance can besides develop by the agricultural spending insured by States to promote the agricultural activity.

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