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ECONOMIC, INSTITUTIONAL, AND CULTURAL DETERMINANTS OF AGRICULTURAL INSURANCE DEMAND ACROSS COUNTRIES

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Abstract

This paper aims to identify the determinant factors in using agricultural insurance and to provide evidence that religion matters, in addition to the institutional and economic ones, plays an explanatory role in agricultural insurance demand for American and European countries in the period 2000-2012.The study adopts a logistic regression modeling technique with 276 cross section observations. The research results show that the agricultural insurance demand is a multidimensional function, which depends on: i) premiums of agricultural insurance, ii) subsidies of agricultural premiums, iii) cultivated surface; iv) education level of farmers, v) yield risk, and vi) religion.
Keywords: Religion; Logit model; Agricultural finance; Demand for insurance

1. Introduction

The importance of insurance for the agricultural activity of a country has led us to explore the main economic, institutional and cultural factors that influence the development of agricultural insurance demand. The paper contributes to the body of the existing research by an extensive econometrical analysis of the influence of the cultural, economic and institutional factors over the demand for agricultural insurance. In spite of the growing interest on the topic, the influence of the cultural factors, as well as the economic and institutional ones, has not been analyzed empirically as widely as it would have been expected because of the lack of reliable indicators. In order to measure the agricultural insurance demand we use i) premiums of agricultural insurance, ii)subsidies of agricultural premiums, iii) cultivated surface, iv) education level of farmers, v) yield risk, and vi) religion.

The economic literature often treats the role of economic, institutional and cultural variables on the life and non-life insurance sector. Starting from those studies, ours contributes to the existing literature focusing attention on the determinants of agricultural insurance demand.

The main objective of this study is to formulate and validate the hypothesis over the role of the cultural variable as a determinant of agricultural insurance demand beside the economic and institutional factors.

Through a theoretical and empirical investigation, we explain the role of cultural factors, added to the economic and institutional ones. One proxy of the cultural dimension used in this study is religion, which is defined as "Christians and Muslims" as a percentage of rural population. We use a panel data set of 23 American and European countries covering the period2000-2012.

The remainder of this article is organised as follows: After presenting in the second section how religion is introduced as a cultural factor in the economic literature of the field, in addition to the economic and institutional ones, we focus in the third section on the presentation of a theoretical and empirical model in which religion is a potential factor, among others, of agricultural insurance demand, followed in the fourth section by a description of data. After that, we present and discuss our estimation results. Finally, in the last section, we conclude the study.

2. Related Literature

The differences in the growth of non-life insurance can be explained, added to the economic and institutional factors, by cultural ones. The cultural factors come into play the link with religion is notably crucial. A lot of researchers and scholars have looked into the relationship between socioeconomic and

demographic characteristics and life insurance consumption. Various studies have identified the determinants of non-life insurance.

Most studies have proved that the decision of purchasing a non-life insurance contract depends on socioeconomic determinants such as education, income, population, inflation, etc. However, Consumers may respond to the insurance demand according to their cultural beliefs, not just on economic rationality, so the cultural dimension has a strong impact on the insurance purchase decisions.

We present in the review various empirical studies that identify economic, institutional and cultural factors as determinants of non-life insurance demand.

Religion and Insurance Demand

The demand for insurance, and particularly life insurance, in a country may be affected by the latter's unique culture. Understanding religion is an important component of understanding a nation's unique culture.

History demonstrates that in the insurance sector, religion cannot oppose economic necessities in the long term. Therefore, religion becomes a cultural factor, which can determine the attitude of the insurant.

Followers of Islam have traditionally been known to disapprove of life insurance because it is considered a hedge against the will of Allah. Unsurprisingly, Browne and Kim (1993) and Meng (1994) found a dummy variable for Islamic countries to be negatively correlated with life insurance demand.

From a historical perspective, the Christian religion and Islam have opposed the creation of insurance mechanisms. It was in the 20th century that the status of insurance became established and its economic necessity more felt, as it is the case today. If one includes now social insurance cover, it is essential to the functioning of modern societies as oil or electricity.

Concerning life insurance demand, we distinguish two types of studies. The first category of studies demonstrates that religion is a determinant of life-insurance demand, besides the economic and institutional ones. Some studies have found that religion has a positive effect on insurance demand (Burnett and Palmer (1984); Ward and Zurbruegg (2000)) while others have found that religiosity negatively impacts insurance demand ((Browne and Kim (1993), and Outreville, (2013)). On the other hand, the second category of studies proves that the religion has no effect on life insurance demand (Park et al. (2011); Esho et al. (2004)).

For the non-life insurance sector, Park, S. C., and Lemaire, J., (2011) found a significant impact of cultural variables on non-life insurance consumption. They tested the effect of four cultural measures (individualism, power distance, masculinity, and uncertainty avoidance) on non-life insurance demand using large international panel data that included 82 countries over a ten-year period. They also introduced affiliation to one of the world's largest religions as cultural variables. Then, they investigated the importance of economic and cultural factors on non-life insurance demand at different stages of economic development.

In our investigation, we explore the religion as a potential determinant of agricultural insurance demand in case of an agricultural yield risk.

This study employs a broader measure of religious inclination by including Christians and Muslims, defined as the ratio of adherents of one religion over the rural population. Yet, it is not a very easy ratio to measure because a lot of people consider themselves "Christians" without practicing at all their religion, and without believing in it. This is supposed to be the same thing for others. While we expect the Muslim share of rural population to be negatively related to agricultural insurance demand, we do not have prior expectations about the sign on the other religion variable.

Education

Education is a demographic determinant that is expected to have a positive impact on the insurance demand. In the academic literature, the level of education in a country is used as a proxy for risk aversion, but there are differences in the results obtained for non-life and life insurance sectors.

Concerning life insurance demand, the opinions diverge between two positions. The first one shows a significant positive influence of education over the demand for life insurance ((Burnett and Palmer,

(1984); Truett and Truett, (1990)). The second one reveals the ambiguity of the results including education (Zietz (2003) and Zietz, E. N. (2003)).

For the non-life insurance sector, the results of empirical studies converge towards the idea that education positively impacts the demand for non-life insurance products. Curak, Dzaja, and Pepur (2013) and Curak, M., Dzaja, I., and Pepur, S. (2013) suggested that education would increase risk aversion and encourage people for non-life insurance demand. Treerattanapun and Treerattanapun, A. (2011) indicated that education would raise risk awareness of risk and lead to financial instability, facilitating the understanding of insurance benefits. Park and Lemaire (2011a) and Park, S. C. and Lemaire, J. (2011a) found a positive relation between education and non-life insurance demand, considering 82 countries for a period of 10 years. Ofoghi and Farsangi (2013) and Ofoghi, R. and Farsangi, R. H. (2013) also proved a significant and positive relationship between risk aversion and auto insurance demand.

Hence, we hope to find a positive relation between the farmers' educational level and agricultural insurance demand.

Premium Subsidies

One important group of factors consists of institutional dimensions such as public policies and regulation. Public policies can be a stimulating factor for the demand of insurance, via regulation suited to insurance, which influences the development of insurance industry. Thus, the penetration in insurance depends on public policies and on the regulation relative to insurance. The agricultural risk management and the role of insurance as a management risk tool have attracted the attention of researchers and decision-makers.

Subsidies of insurance are analyzed in what follows to see if they constitute a potential determinant of non-life insurance demand.

Several empirical studies have proved that subsidies are typically introduced to stimulate demand for a certain type of insurance. Other studies have found that subsidies of insurance are not a determinant of insurance demand. Subsidies are usually administered through one of two channels: direct subsidization or expost compensation.

For non-life insurance demand, Doherty and Dionne (1993), Miranda and Glauber (1997), and Mahul (2001) found evidence that considering the systematic character of yield risk, without the state intervention by governmental subsidies, premiums of agricultural insurance would increase considerably compared to the case where there was no subsidy. In fact, the insurance mainly serves to distribute the risks between fortunate and unlucky, each paying the esperance of disaster; but if the insurance is subsidized, expected payments will be superior to bonuses.

According to Alberto and Zilberman (2008), the explanatory factors of the limitation of the demand for agricultural insurance were the incapacity of farmers to seize the advantages of the application of insurance to protect themselves against agricultural risks. Hence, they could protect themselves against the yield risks by *ad hoc* investments, for example by installing a system of irrigation to avoid a drought. The farmers would make an inventory culture profit cost to know if it was better to insure or to invest. Subsidies of insurance would play in this case an important role.

Raja Chakir and Julien Hardelin (2010) proved that a substantial number of production risks caused by climatic and phytosanitary hazards would remain uninsurable without the government support in favor of crop insurance.

In this study, we are concerned with the influence of agricultural premium subsidies on the attitudes of insurant farmers.

Price of Insurance

The association linking price of insurance and life insurance consumption has seen empirical attention. Past studies showed a positive relationship between the price of insurance and insurance life demand (Ward and Zurbruegg, 2002). Nevertheless, the studies that have employed the fixed-effect model statistically illustrate an insignificant positive association between the price of life insurance and the demand for life insurance. Whereas, in the pooled cross-sectional models an insignificant negative relation has been reported (Hwang and Greenford, 2005).

These researchers demonstrated that the lesser the price of insurance, the higher its expected demand. Browne M. J and Kim (1993) identified the factors that would lead to a variation in the demand for life insurance across countries. They found that important factors were the price of insurance and whether Islam was a predominant religion in country. Goodwin (1993, 2001) tried to show that the decision of insurance purchase would answer in an inelastic way the evolution of the rate of insurance contribution.

The elasticity of the demand for insurance is a critical parameter to estimate the effects of the politics of insurance. The evaluation of the politics of insurance should consider the variation of the small elasticity of demand which can better characterize the behavior of farmers due to the changes of premiums.

The demand for any product or service is affected by its price. The price of insurance is expected to be negatively correlated with insurance demand. Esho et al. (2004) used a similar measure in their study of price determination. According to Ranger, N. and Swenja, Surminski (2011), the increase of the risk levels with the climate change could reduce the willingness to pay by increasing the price of insurance. However, willingness to pay grows by raising the level of a perceived risk.

The potential negative impacts of a climatic change on the demand for insurance may be especially felt in regions with a strong exposure to the climatic hazards.

The demand for agricultural insurance is a decreasing function of the premiums of agricultural insurance, so as to check the law of demand. It supposes that any increase in agricultural risks can raise the demand for agricultural insurance. Nevertheless, the function of the demand for agricultural insurance is a decreasing function of the premiums of agricultural insurance.

The correlation between the demand for agricultural insurance and agricultural premiums, which farmers are ready to pay, is *ceteris paribus*. The more premiums of agricultural insurance are brought up, the more the demand for agricultural insurance is low.

Therefore, we hope to find a negative correlation between the agricultural insurance demand and the price of agricultural insurance.

Yield Risk

In order to capture the effect of yield risk on the demand of insurance, we follow most of the literature of Goodwin, B., (1993), who presented an empirical assessment of the demand for crop insurance by Iowa corn producers. An adverse selection in the insured pool suggests that producers with differing levels of loss-risk have different demand elasticities. Loss-risk is included in the empirical analysis and is found to influence the elasticity of demand. Goodwin et al. (2004) include the individual coefficient of a yield variation to measure the risk magnitude. In fact, a high coefficient of variation reflects a higher exposure to a yield risk, hence an incentive to take insurance.

Raja Chakir and Julien Hardelin (2010) investigated the determinants of rapeseed hail insurance and chemical input decisions using an individual panel data set of French farms covering the period from 1993 to 2004.They found that insurance demand was also positively influenced by the yield's coefficient of variation and the loss ratio, and negatively influenced by proxies for wealth (including CAP subsidies) and activity diversification.

We thus include a yield risk index as an explanatory variable of agricultural insurance demand.

Cultivated Surface

The demand of agricultural insurance is as a function of the cultivated surface assigned to the agricultural production. Agricultural production will certainly be affected by the potential of an agricultural land, which will be followed by changes in insurance cover of crops (Birovljev et al. 2015). All areas assigned to production do not have the same quality; this does not prevent that agricultural insurance could play a role in the improvement of production.

Geoffroy et al. (2012) tried to understand which factors would affect the crop insurance decision in France and in Italy. It was the first attempts to measure the determinants of crop insurance purchases in two European countries. It was noticed that purely agricultural indicators such as the size of the farm, measured by the cultivated area, and diversification, measured by the number of cultivated crops, were key factors for the insurance purchase decision in both countries.

Consequently, a cultivated surface is expected to have an effect on agricultural insurance demand.

Our empirical investigation has allowed us to identify the potential factors of non-life insurance demand (Cf.Table1, Appendix. 1), and our contribution will be an investigation of the potential determinants of agricultural insurance demand in case of a yield risk.

3. Modeling Agricultural Insurance Demand

Based on the motivation in the previous section, we firstly present the two theories that could answer the question of our research, namely the theory of consumer behavior and the socio-cultural model. Then, we develop a theoretical model to identify the determinants of agricultural insurance demand. Finally, we expose an empirical validation by testing certain hypotheses to identify to possible factors of agricultural insurance demand.

According to the traditional theory of consumer behavior, the consumer is certain of the outcomes arising from alternative acts or decisions. However, choices made by consumers are subject of uncertainty. The work of Neumann and Morgenstern[14] described the hypotheses of the theory of consumer behavior in case of uncertainty.

One theory that informs people the attitude towards insurance is the social action theory. By which Max Weber[15] explained that human actions were significant and that certain reasons would push people into various kinds of actions. To Weber, there were three kinds of actions: traditional (based on customs and habits), affective (based on the emotional state of the individual at a particular time), and rational (based on a clear awareness of a goal) (Haralambos and Holborn)[16]. This also implies that certain factors tend to influence one's behavior towards insurance. People might choose to have a preference for insurance due to intuitive or cultural underpinnings. On the other hand, people can rationally decide to have an insurance policy for clearly economic reasons. In the context of this study, culture affects the people's attitude from taking up insurance cover.

3.1 Theoretical Model

We present a theoretical model which allows identifying two functions of farmer utility: the first one describes the utility of the farmer without insurance and the second one represent the utility of the farmer with insurance. Our purpose is to identify the factors which probably explain insurance. In our paper and from the standard theoretical model, we target identifying the determinants of the demand for agricultural insurance.

- The utility of the farmer without insurance is as follows :

$$\overline{U} = s\bar{y} - \frac{a}{w} s^2 \bar{\sigma}^2 \quad (1)$$

Where $\overline{U}$ is the *adhoc* Utility, y is the gross margin by the area of surface, $\bar{y}$ is the average, $\bar{\sigma}$ is the standard deviation, *s* is the surface allocated by the farmer, *w* is the wealth of the farmer and *a* is the relative aversion for the risk.

- Then the utility of the farmer with insurance becomes :

$$\hat{U} = s\bar{y} - \frac{a}{w} s^2 \hat{\sigma}^2 - sc \quad (2)$$

Where *c* is the cost of the insurance of the unit area.

The farmer will take the insurance if,

$$\hat{U} - \overline{U} > 0 \quad (3)$$

or

$$\frac{a}{w} s^2 (\bar{\sigma}^2 - \hat{\sigma}^2) - sc > 0 \quad (4)$$

[14]John von Neumann and Oscar Morgenstern, Theory of Games and Economic Behavior, Princeton: Princeton University Press, 1994.

[15]Max Weber, Economy and Society, Vol. 1, Berkely: University of California Press, 1924.

[16]Mike Haralambos and Martin Holborn, Sociology: Themes and Perspectives, London: Harper Collins Publishers, 2004.

However, *s* is not independent of w, because, obviously, the richer the farmer, the larger the cultivated area. We shall put:

$$s = kw \tag{5}$$

Besides, c depends on $\hat{\sigma}$:

$$c = z/\hat{\sigma} \tag{6}$$

The more $\hat{\sigma}$ is small, the more *c* is big.

Accordingly, the condition $\hat{U} - \overline{U} > 0$ becomes:

$$ak^2 w(\overline{\sigma}^2 - \hat{\sigma}^2) - kwz/\hat{\sigma} > 0 \tag{7}$$

or

$$W \rangle 0 \quad and \quad k \rangle 0 \tag{8}$$

$$ak(\overline{\sigma}^2 - \hat{\sigma}^2) - c > 0 \tag{9}$$

Thus, we expect that the probability of insurance increases with:

1/ The relative aversion for the risk (It depends on the behavior of the farmer. Nevertheless, the religiosity is introduced only little here because if there is a religious prohibition on insurance, there will not be any aversion to risks, even with people who have a strong one.)

2/ The unit cost of insurance (It is obvious, and it explains the role of subsidies.)

3/ The relation between the wealth of the farmer and the cultivated surface.

3.2 Empirical Model and Data

We target identifying the determinants of the demand for agricultural insurance for a panel of heterogeneous countries. There is a distinction between these regions in term of programs of agricultural insurance applied to face agricultural risks, type of insurance contracts, agricultural risk management policies and type of insured agricultural crop. In fact, what is common between the set of these countries, is the choice of agricultural insurance as a management tool of yield risks. Furthermore, what interests us is to see what motivates farmers to ask for agricultural insurance. We present briefly the main characteristics of the agricultural insurance programs in American and European countries over the period 2000-2012 **(**cf. Table 2, Appendix. 1).

From an econometric point of view, we integrate into the estimations the variable regions as a dummy variable that will carry the specificity of every region if it is up to American and European countries. We will show whether farmers may respond to agricultural insurance demand according to their cultural belief, as well as institutional and economic factors, by testing the seven hypotheses described in Table 3.

Table 3. Tested hypothesis

Hypothesis	Tested effect on agricultural insurance
H1:	Agricultural insurance demand decreases with agricultural insurance premium
H2:	Agricultural insurance demand increases with level of farmers' education
H3:	Agricultural insurance demand increases with yield risk
H4:	Agricultural insurance demand increases with agricultural premium subsidies
H5:	Agricultural insurance demand increases with cultivated surface
H6:	Agricultural insurance demand depends on region
H7:	Agricultural insurance demand decreases in Islamic countries and increases in Christian countries

The logistic regression model is a nonlinear model that is used whenever the dependent variable of the research study is binary and it is considered the most appropriate. We use the standard binary logistic regression to study the determinants of demand for agricultural insurance in American and European countries because of its simplicity. The concept of logistic model is based on the Bernoulli distribution which estimates the probability of the dependent variable to be 1. This is the probability that some events happen. Most of the existing studies have focused only on the decision to purchase insurance by considering the demand for insurance as a binary variable identifying whether the farmer participates or does not (Horowitz and Lichtenberg (1993) and Smith and Baquet (1996)). One approach is to consider the multiple linear regression model (assuming Y has a normal distribution of the form).

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots \beta_n X_n \tag{10}$$

$$E[Y] = p = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots \beta_n X_n \tag{11}$$

In equation 12, the expression is known as a linear probability model. As a logistic model, it is associated with a linear probability structural problem. Hence, it is good to study the models incorporating a curvilinear relationship between X and p. Mostly, the transformation of this situation is the logistic defined as:

$$Logit\ (p) = \log\left(\frac{p}{1-p}\right)$$

$$p_i = E(Y = \frac{1}{X_i}) = \frac{1}{1 + e^{-\left(\beta_0 + \sum_i^n \beta_i X_i\right)}}$$

$$prob\,(event) = p(X) = \frac{e^{\left(\beta_0 + \sum_i^n \beta_i X_i\right)}}{1 + e^{\left(\beta_0 + \sum_i^n \beta_i X_i\right)}} \tag{12}$$

Thus, the log of odds (logit) is presented in equation 13.

$$\log \frac{p}{1 - P} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots \beta_n X_n \tag{13}$$

Where β_0 is the intercept $\beta_1 \ldots \beta_n$ are the slope coefficients, $X_1 \ldots X_n$ are the exogenous variables. The effects in the logistic model refer to odds; and the estimated odds at one value of X divided by the estimated odds at another value of X is an odds' ratio.

The study focuses on the determinants that have an effect on the agricultural insurance demand for 23 countries for the period of 2000-2012, selected on the basis of data availability and presented in Table 4. (Appendix.1). The possible outcome is planning either to purchase an agricultural insurance contract (Y=1) or not (Y=0). Based on past empirical and theoretical studies, we have included seven independent variables in the empirical logistic regression model, which may explain the determinants of agricultural insurance demand. These variables are presented in Table 5.

Table 5. Variable Descriptions, Expected Sign and Data Sources

Categories	Variables	Definition	Hypotheses	Expected sign	Data sources
Cultural variable	Religion: Religious rural population shares - (% Muslim in rural population, % Christian in rural population)	Scale variable, years	We expect Muslims share of rural population to be negatively related to agricultural insurance demand	+/-	UNSD Demographic statistics
Demographic variable	Education:Farmers' education level - (Educ)	Scale variable, years	We expect a positive relation between farmers' education level and agricultural insurance demand	+	UNSD Demographic statistics
Institutional variable	Agricultural premium subsidies - (Subsidy Agri Prim)	Scale variable, years	Agricultural premium subsidies have impact on attitudes of insurant farmers	+/-	the International Observatory of Agricultural Insurance Database
Insurer action parameters	Agricultural insurance premium -(Agri prim)	Scale variable, years	We hope finding negative correlation between agricultural insurance demand and price of agricultural insurance	-	the International Observatory of Agricultural Insurance Database
Insurer action parameters	Yield risk-[17] (Yield risk)	Scale variable, years	We expect a positive relation between yield risk and agricultural insurance demand	+	the International Observatory of Agricultural Insurance Database
Economic variable	Cultivated surface - (Surface)	Scale variable, years	Cultivated surface is expected to have an effect on agricultural insurance demand	+	Databases of agriculture ministries
Demographic variable	Region - (Region)	Dummy variable: 1=American countries; 0 other wise	Agricultural insurance demand depends on region	+/-	23 countries

Source: Author synthesis

[17]The indicator is defined by the Center of Study and Investigation for the management of Agricultural Risk, by the authors Ballestero. M.,and Bielza. D., as being the indicator of the average losses compared with the trend or the expected value of the losses compared with the trend. (CEIGRAM , 2012)

$$I_{pt} = \frac{\sum_{i=1}^{n} \frac{\max(t_i - y_i, 0)}{t_i}}{n}$$

With n: number of years: value of the variable analyzed in the year i; and t: value of the trend in the year i

Religion has included in the model as a cultural factor and this independent variable hypothetically may have a positive or negative effect on agricultural insurance demand. Especially, religious beliefs can affect the demand for agricultural insurance.The farmers' educational level, the cultivated surface and the yield risk are other variables in our model, which were hypothetically expected to have a positive relationship with agricultural insurance demand. Agricultural premium subsidies are added to our empirical model as an institutional variable to capture the effect of yield risk management on agricultural insurance demand.

Hypothetically, we could expect a positive or negative relationship with the demand for agriculture insurance. Moreover, we have added an agricultural insurance premium as a potential determinant of agricultural insurance demand. Hypothetically, we expected that the agricultural insurance premium had a negative effect on demand. Finally, regionshave been added as a dummy variable because American and European farmers might not have the same attitudes vis à vis agricultural insurance contracts.

4. Estimation Results and Discussion

In what follows, we present the results of estimations to identify the explanatory factors of agricultural insurance demand for American and European countries in the period 2000-2012.

First of all, we proceed by an identification of the sources of not exogeneity of independent variables to justify estimation method used. Then, we explain briefly the exogeneity procedure Hausman Test. Then, we provide and discuss the results of the estimations with and without cultural factor as well as economic and institutional ones. Finally, we identify results of marginal effects and results of elasticities' demand to answer to our hypotheses and to the objective of the paper.

4.1 Sources of Non Erogeneity Of Independent Variables

The OLS method justified under the hypothesis of exogeneity supplies OLS estimators without bias and is convergent only when the model is apparently linear. Generally, we distinguish three situations which can be at the origin of dependence between the systematic party and the stochastic one of regression, namely: 1) simultaneity or inverse causality, 2) bias of omitted variable or unobserved heterogeneity, and 3) errors of measure.

- **Simultaneity or inverse causality**

The first source of endogeneity concerns the possibility of bidirectional causality between aregressande and at least one regressor. The direct consequence is that the hypothesis of exogeneity is obviously violated, and thus Cov (X, u) = E (X, u) $\neq$ 0. In these conditions where, the orthogonal asymptotic between the error and the regressor is not any more respected; the estimation by the OLS becomes unjustified.

- **Bias of omitted variable or unobserved heterogeneity**

This second source of endogeneity concerns the situation where the model would include explanatory variables, although relevant, unavailable or simply omitted by the model. Such a situation also introduces a correlation between exogenous variables and hazards. The consequence is the inefficiency of the OLS estimation.

- **Errors of measure**

Besides the simultaneity and the bias of an omitted variable, the errors of Classical Error - in – Variables (CRV) measure can also introduce endogeneity into observation. As a result, the OLS method is unjustified.

When one of these three proofs is verified, and when we are in the presence of a linear model with endogenous explanatory variables, the method of instrumental variables becomes particularly suited and preferred to the OLS, because it is adapted well to the treatment of the endogeneity of regressors.We present in what follows the exogeneity procedure of theHausman test.

4.2 Exogeneity Procedure of Hausman Test

The Hausman test, known also as the Wu-Hausman test, allows testing the hypothesis of the exogeneity of a regressor. The idea of the test is that if a regressor is endogenous, the simulated residue through the estimation of the instrumental equation will bring useful information for the prediction of the regressande.

Let us consider the linear model below:

(1)$Yt = \zeta 0 + \zeta 1X1t + \zeta 2X2t + ut.$

If X2t is endogenous and W is a vector of valid instruments, then the equation of instrumentation is written as:

(2)$X2t = \beta 0 + \beta 1w1t + \beta 2w2t + vt.$

The Hausman test examines the exogeneity hypothesis against that of endogeneity one and takes place in three stages, as described below:

(1) Estimate the equation of instrumentation (2) by the OLS and simulate the residue v (2) Include v as an explanatory variable in the equation of interest (1), then estimate the model (3) Test the significativity of the associated coefficient in v.

If the coefficient associated in v is statistically significant, then the exogeneity hypothesis of the variable X2t is released and the recourse to the method of the instrumental variables is then justified and allows a convergent estimation, better than that obtained by the OLS. In case we consider several endogenous explanatory variables, it is necessary to test jointly, through the classic Fisher test the significance of the residues of every instrumentation equation.

4.3 Exogeneity of Hausman Test

To test if there is a relation between dependent and independent variables in our equation, we perform a Durbin-Wu-Hausman[18]test for the hypothesis that: (1) the agricultural insurance demand is exogenous to the agricultural insurance premium use, (2) the agricultural insurance demand is exogenous to the insurance use of subsidies, (3) the agricultural insurance demand is exogenous to the farmers' education level, (4) the agricultural insurance demand is exogenous to the yield risk, (5) the agricultural insurance demand is exogenous to the cultivated surface, (6) the agricultural insurance demand is exogenous to the region, and (7) the agricultural insurance demand is exogenous to the religion. The test results confirm the exogeneity of the regressors Xi compared with the term of error.As a result, the estimations can be driven by means of OLS.

The test results are presented in Table 6 and show that the exogeneity hypothesis is accepted for these variables: agricultural insurance premium, subsidies of agricultural insurance, education of farmers, yield risk, cultivated surface, region and religion in the insurance demand equation. These results suggest that the agricultural insurance demand can be affected by economic, institutional and religion factors. Therefore, we need to estimate the agricultural insurance demand by using a logit regression.

[18]The "Durbin-Wu-Hausman" (DWH) test is numerically equivalent to the obtained standard "Hausman test" in which both model forms must be estimated. Under the null hypothesis, it is distributed Chi-squared with m degrees of freedom, where m is the number of regressors specified as endogenous in the original instrumental variables' regression.

Table 6. Durbin-Wu-Hausman Test Results

Variables	P. Value	DF	Null hypothesis	Test result
Agricultural insurance premiums (Agric prim)	0.016	150	Agricultural insurance demand is exogenous to agricultural insurance premium use	Accepted at 5% level of confidence
Subsidies of agricultural insurance premiums (Subsidy Agric prim)	0.009	150	Agricultural insurance demand is exogenous to subsidies insurance' use	Accepted at 5% level of confidence
Farmers'education level (Educ)	0.000	150	Agricultural insurance demand is exogenous to level of education of farmers	Accepted at 5% level of confidence
Yield risk (Yield. Risk)	0.000	150	Agricultural insurance demand is exogenous to yield risk	Accepted at 5% level of confidence
Cultivated surface (Surface)	0.000	150	Agricultural insurance demand is exogenous to cultivated surface	Accepted at 5% level of confidence
Rgion=1, for America and 0 otherwise (Region)	0.005	150	Agricultural insurance demand is exogenous to region	Accepted at 5% level of confidence
Muslim as percentage of rural population (Muslim)	0.005	150	Agricultural insurance demand is exogenous to Muslim religion	Accepted at 5% level of confidence
Christian as percentage of rural population. (Christian)	0.005	150	Agricultural insurance demand is exogenous to Christian religion	Accepted at 5% level of confidence

Source: Author synthesis

We estimate a logit equation model of agricultural insurance demand for 23 countries over the period 2000-2012. The results of estimations are presented in the following table. A first regression is without a cultural factor (religion), but the second regression is made by introducing religion.

4.4 Results of Marginal effects

Prior to the logistic regression analysis, the multicollinearity between independent variables was tested to circumvent ambiguity about the results. The results have shown the value of the variance inflated factor, which is less than 1.498 in case of all independent variables. These results have clarified that there is not amulticollinearity problem among the independent variables of the model.

The descriptive statistics of the study are provided in Table 7 (Appendix. 1). All variables indicate very little dispersion and have a normal distribution.

According to the results of the logistic regression, the adjusted R^2 is 68.7 percent without considering religion and it is estimated to be 78.74 percent by retaining the variable religion indicating a good-fit of regression. Besides, the DW statistic is almost 2, supporting the assumption that there is no serial correlation between residuals. We also apply the Wald test to investigate whether the coefficients are statistically different from zero or not. Wald test results indicate that coefficients are statistically different from zero. In addition, the residuals have a normal distribution.

Furthermore, because of the heterogeneity of the studied sample, we test for potential presence of heteroscedasticity usingthe Breusch-Pagan/Cook-Weisberg test[19].

We provide the results of the tests for the homoscedasticity and exogeneity hypotheses at the bottom of the table, which contains the estimation results. Added to that, we identify in Table 8 the effects on the odds of taking agricultural insurance. Finally, we explore the results ofelasticities'demand in Table 9.

Table 8. Results of Marginal Effects

	Logistic regression coefficients (without religion)					**Logistic regression coefficients (with religion)**				
	Coefficients (β)	**SE**	**Wald test**	**Sig.**	**Exp (β)**	**Coefficients (β)**	**SE**	**Wald test**	**Sig.**	**Exp (β)**
Economic variable										
Agricultural premium	-0.351	0.115	-3.06	0.002***	-0.552	-6.331	1.441	-4.39	0.000***	-0.003
Cultivated surface	0.344	0.196	1.76	0.004***	0.054	1.865	0.923	2.02	0.043**	0.039
Region=1, for America and 0 other wise	1.283	0.600	2.14	0.032**	0.201	7.830	5.018	1.56	0.019*	0.401
Education	0.215	0.154	1.40	0.001***	0.033	3.052	0.976	3.12	0.002**	0.004
Yieldrisk	1.199	0.461	2.60	0.009***	0.188	11.560	2.361	4.90	0.000***	0.002
Institutional variable										
Subsidies agric premium	0.016	0.078	0.02	0.010**	0.002	1.12	4.10	2.73	0.006**	8.03
Cultural variable										
Percentage of Muslims in rural pop.						-1.44	1.274	-1.13	0.257	-0.006
Percentage of Christians in rural pop.						0.707	0.209	3.38	0.001***	0.023
Constant	5.704	1.770	3.22	0.001***	0.171	11.006	3.765	5.01	0.000***	1.231
(Countries X year) (N X T)	276					276				
LR χ2(.) (6)	27.68					161.38				
Pr > χ2(.)	0.0001					0.0000				
R^2	0.687					0.7874				
B-Pagan χ2(.)	250.16					293.99				
Pr > χ2(.)	0.000					0.0000				
Hausman χ2(.)	62.32					54.3				
Pr > χ2(.)	0.002					0.015				

[19]The Breusch-Pagan/Cook-Weisberg test is based on the null hypothesis whose variance is constant. Therefore, when the probability is large (> 5 %), we accept the null hypothesis of a constant variance. If heteroscedasticity is detected, standard errors are estimated using the White's procedure (in order to obtain robust standard errors).

($\boldsymbol{\beta}$): Coeffcients of logistic regression; SE: Standard Error; Sig: Signifcance level, Exp ($\boldsymbol{\beta}$): odds ratio of taking agricultural insurance (*signifcant at 1%) (**signifcant at 5%) (***signifcant at 10%). Source: Author synthesis.

As indicated in hypothesis 1, an agricultural premium has negative and significant effect on the odds of taking agricultural insurance. An agricultural premium reduces the odds of taking agricultural insurance by -0.351 without religion and -6.331 with religion. This result is consistent with Browne et al. (2000) and Ranger, N.Swenja, and Surminski., (2011). By contrast, and as supposed in hypothesis 2, the sign of farmers' education is positive, i.e; a higher farmers' education increases the odds of taking agricultural insurance,which is statistically significant at a 0.05 level. This result confirms the study of Curak, Dzaja, and Pepur (2013), and Curak, M., Dzaja, I., and Pepur, S. (2013). As suggested in hypothesis 3, the sign of a yield-risk variable is positive and significant at a 0.05 level indicating a rise in the odds of taking agricultural insurance. This result is consistent with Goodwin et al. (2004). The sign of a subsidies' agricultural premium is positive (0.016 without religion and 1.12 with religion)and significant ata 0.01 levelto the odds of taking agricultural insurance,supporting hypothesis 4. This resultis consistent with that of Doherty and Dionne (1993); Miranda and Glauber (1997); Mahul (2001).As indicated in hypothesis 5, the agricultural insurance demand goes up with the cultivated surface. It has a positive influence of 0.344 on the odds of taking agricultural insurance and it is statistically significant at a 0.05 level without retaining religion in estimation. It is positively influenced positively by 1.865 which is the odds of purchasing agricultural insurance, taking religion in estimation. This result confirms the study of Geoffroy et al. (2012).

Table 8 shows that a region rises by 1.283 to take agricultural insurance without religion and by 7.83 with religion, which is statistically significant at a 0.05 level. In other words, American countries are more likely to take agricultural insurance than European ones. This result is supporting hypothesis 6.

By testing if the variable religion could constitute a determinant of agricultural insurance demand in American and European countries, Table 8 demonstrates that Christian farmers are motivated to demand agricultural insurance to face yield risks. By contrast, Muslim farmers in rural population reduce the odds of taking agricultural insurance by -1.44. Muslim farmers are also statistically insignificant, so that being Muslim has no effect on agricultural insurance consumption in American and European countries. This result is consistent with Browne and Kim (1993) and Outreville (2013), contrary to hypothesis 7.

The table results indicate that farmers with Christian beliefs are more likely to take agricultural insurance than Muslim ones. The coefficient of Christians in the percentage of rural population is positive and is statistically significant at a 0.001 level. Christian farmers add 0.707 to the odds of taking agricultural insurance.

According to the results above, the effect of religion on agricultural insurance demand in American and European countries is insignificant. The result confirms the study of Jean Lemaire, Harry J. Loman and Jonathan Mc Beth (2010).

In addition, the first six hypotheses (cited in Table 3) are verified in the presence of the religionvariable as a potential determinant of agricultural insurance demand. We notice that the coefficients of estimated variables in the presence of religion keep the same sign and significance found in the absence of religion. An agricultural premium had a negative impact on the odds of taking agricultural insurance in the presence of religion and it is statistically significant at a 0.001 level (hypothesis 1). However, the farmers' educational level, the yield risk, the subsidies of agricultural insurance, and the cultivated surface have a positive relationship with the odds of taking agricultural insurance, and they are statistically significant. This result confirms hypotheses 2, 3, 4, 5 and 6.

In fact, a comparison between both regressions confirms that consideringthe religion variable improves the empirical results of the estimation, which could confirm at this stage and for the panel of chosen country that the demand for agricultural insurance depends on economic and institutional factors of cultural variables as well.

4.5 Results of Elasticities' Demand

The previous paragraph has presented marginal effects' results in both cases with and without retaining a culture factor as a determinant of agricultural insurance demand in addition to economic and institutional ones. In this paragraph, we interpret the empirical results in terms of elasticity. In fact, the demand elasticity measures the degree of sensibility of agricultural insurance demand in the variations of factors determinant of agricultural insurance. The estimation results are reported in Table 9.

The elasticity demand-price allows analyzing the variations in the percentage of agricultural insurance premiums and the variations in the percentage of purchasing agricultural insurance. We can justify that the demand law, *ceteris paribus*, is any increase in agricultural insurance premiums that reduce the demand for agricultural insurance. A decrease 1 % in agricultural insurance premium is associated with a 0.446% increase in agricultural insurance demand.

Price variation is not the only element that affects demand. Other socioeconomic and cultural factors affect agricultural insurance demand, such as subsidies of an agricultural premium insurance variation, a farmer's education level distinction, a culture variation, the type of agricultural risk and region.

An increase of 1 % in the subsidies of agricultural premiums leads to a rise of 0.332 % in the probability to demand agricultural insurance. If the farmer's education level goes up by 1%, the agricultural insurance demand will grow by 0.079%.

A 1% decline in yield risks is associated with a 0.203% increase in the agricultural insurance demand.

Agricultural insurance demand varies positively with the variation of cultivated surfaces. An increase of 1 %on the cultivated surface leads to rise of 0.02% in the probability to demand agricultural insurance.

A fall of 1% in Muslims in a rural population is linked to a 0.136% growth in agricultural insurance demand. However, an increase of 1% in Christian in a rural population results in a rise of 0.297% in the probability to demand agricultural insurance. This result confirms one of our hypotheses, which stipulates that the agricultural insurance demand is as a function of culture factors rather than socioeconomic ones.

Whatever analysis in terms of demand elasticities or marginal effects, the agricultural insurance demand depends on economic, institutional and cultural factors. The agricultural insurance demand is sensitive to economic (agricultural insurance premiums, yield risk, levelsof farmers' education), institutional (subsidies of agricultural insurance premium), and cultural (religion) variations.

Table 9. Results of demand elasticities

Variable	Ey/dx	Std. Err.	Z	P>|Z|
Agricultural premium	-0.446	0.0144	-3.25	0.001
Subsidies agric. Premium	0.332	0.061	0.51	0.060
Education	0.079	0.0163	1.20	0.025
Yield risk	-0.203	0.0605	-3.35	0.001
Cultiv. surface	0.020	0.021	0.97	0.014
Region=1, for America and 0 otherwise	0.117	0.127	0.14	0.088
Percentage of Muslims in rural pop.	-0.136	0.003	-3.60	0.000
Percentage of Christians in rural pop.	0.297	0.017	1.72	0.086

Source: Author synthesis.

5. Conclusion

In this paper, we have examined the determinants of demand for agricultural insurance in American and European countries. This empirical research has been based on 276 observations and the data have been obtained from International Observatory of Agricultural Insurance Database. The logistic regression model has been used to analyze the data. This study has presented some significant understanding into agricultural insurance demand.

According to the results of the study, agricultural insurance premiums, cultivated surfaces, agricultural premium subsidies, farmers' education levels, yield risks and religionshave been statistically significant determinants of agricultural insurance demand in the studied.

In addition, the effect of a cultivated surface, agricultural premium subsidies, a farmers' education level and a yield risk on the agricultural insurance demand has been positive and significant, where an agricultural premium has been negatively associated with it.

We have also found that Christian farmers are more likely to take agricultural insurance demand in American and European countries. Thus, this result has highlighted that religion is an important factor in purchasing an agricultural insurance contract. Furthermore, Muslim farmers are not motivated to demand an agricultural insurance contract in the studiedarea. Sucha result can be explained by the attitudes of Muslim farmers vis a vis insurance in general and agricultural insurance in particular.

The results have shown that the development of agricultural insurance must be accompanied by economic and institutional policies such as agricultural development policies and agricultural management yield risks. In addition to those policies, we argue that culture is a potential determinant of agricultural insurance demand, beside the economic and institutional ones. The overall results of this study imply good information for policy and decision makers to implement policies regarding agricultural insurance policies. It is also recommended that awareness has to be increased about non-life insurance, in particular agricultural insurance, to get fruitful results from the agricultural insurance industry.

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Appendix 1.

Table 1. Empirical determinants of non-life insurance demand

Categories	Variables	Hypotheses
Cultural variable	Religion	Religion has a significant impact on non-life insurance consumption. ***We expect that Muslims share of rural population is related negatively to agricultural insurance demand.***
Demographic variable	Farmers' educational level	Education is a demographic determinant that is expected to have a positive impact on the insurance demand. Education encourages people to non-life insurance demand. Education increases the awareness of risk and leads to financial instability, facilitating the understanding of insurance benefits. ***We hope to find a positive relation between farmers' educational level and agricultural insurance demand.***
Institutional variable	Agricultural premium subsidies	Agricultural insurance Premium Subsidies protect farmers against the risks of yield by investments *ad hoc.* ***Agricultural premium subsidies have an impact on the attitudes of insurant farmers.***
Insurer action parameters	Agricultural insurance premium	The demand for agricultural insurance is a decreasing function of the premiums of agricultural insurance. ***We hope to find a negative correlation between agricultural insurance demand and the price of agricultural insurance.***
	Yield risk	A high coefficient of variation reflects higher exposure to yield risk and, thus, an incentive to take insurance. Insurance demand is positively influenced by the yield's coefficient of variation and the loss ratio. ***A yield risk index is supposed as explanatory variable of agricultural insurance demand.***
	Cultivated surface	The demand of agricultural insurance is a function of the cultivated surface assigned to the agricultural production. ***Cultivated surface is expected to have an effect on agricultural insurance demand.***

Source: Author synthesis

Table 2. Agricultural insurance systems in American and European countries

	Specific mechanisms of insurance	Statistical data	Cultural (religion aspects)
American Countries	.A program of additional insurance (Supplemental Coverage Option, SCO) and a program of assistance in case of natural disaster were developed to manage agricultural risk. .Agricultural insurance was supported by public sector, insurance companies and public-private partnerships (PPP).	Agricultural insurance statistics are from Agriculture Ministries and from the **International Observatory of Agricultural Insurance.** .Religion's data which represent percentage of rural farmers who are Christian and Muslim come from **UNSD-Demographic statistics.**	Agricultural American culture is made up of many different norms and religious beliefs follow the same pattern. There are many different affiliations in the US and as a country; it is one of the most religious areas in the world. The majority of Americans Farmers identify themselves as Christians.
European Countries	.Insurance systems in agriculture have been developed over the 40 previous years under the supervision of the governments and within the framework of the European Common Agricultural Policy (CAP). In France, a public indemnity mechanism called the National Guarantee Fund for farming calamities (FNGCA) was set up; in Italy, the"Fondo di SolidarietàNazionale in Agricoltura" (FSN) was instituted in 1974 with the aim of providing farmers the means to effectively manage their production risk, in Espagne, the Consorcio de Compensación de Seguros (CCS) espagnol was set up… .The main risk management tools in Europe are Calamities Funds, Mutual Funds and Insurances. Aid is organised in the form of compensation or funds partially financed by agricultural sector. Or, *Ad hoc* aid given when there is a catastrophic risk. There are direct subsidies for insurance or support for re-insurance, either in public insurance or private one.	Agricultural insurance statistics are from Agriculture Ministries and from the **International Observatory of Agricultural Insurance.** . Religion's data which represent percentage of rural farmers who are Christian and Muslim come from **UNSD-Demographic statistics.**	The largest religion in Europe is Christianity. Three countries in Southeastern Europehave Muslim majorities.

Source: Author synthesis

Table 4. **Sample of countries**

Countries (2000-2012)
American Countries
Argentina
Australia
Canada
Chile
Costa Rica
Colombia
Dominic Republic
Mexico
Panama
Paraguay
Peru
Uruguay
USA
Venezuela
Brazil
Ecuador
European Countries
Austria
France
Greece
Italy
Russia
Portugal
Spain

Table 7. Descriptive statistics for independent variables

Variable	**Definition**	**Insurance = 0**	**Insurance = 1**
		Mean (std. dev.)	**Mean (std. dev.)**
Subsidy agri. prim	**Subsidies agric premium**	8.926 (7.132)	7.677 (7.979)
% Christian in rural population	**Percentage of Christians in rural pop.**	91.624 (6.056)	79.452 (26.391)
% Muslim in rural population	**Percentage of Muslims in rural pop.**	1.057 (1.433)	2.473 (4.118)
Region = 1 if American countries = 0 if European countries	**Region**	1.25 (0.437)	1.461 (0.748)
Surface	**Cultivated surface**	4.530 (3.634)	4.651 (3.356)
Educ.	**Farmers' education level**	5.927 (2.038)	6.465 (3.021)
Agric prim	**Agricultural premium**	15.599 (1.340)	14.293 (5.033)
Yield. risk	**Yield risk**	1.318 (0.262)	0.996

Source: Author synthesis