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Editor-in-chief
Maurizio Raeli

Managing Editor
Giulio Malorgio

Institutional Relations Manager
Debora Degl'Innocenti

Editorial office
Bononia University Press
Via U. Foscolo, 7
40123 Bologna (Italy)
tel.: +39 051 232882
fax: +39 051 221019
email: newmedit@iamb.it

Paper submission
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Improving the economic sustainability of Italian farmers: An empirical analysis of decision-making models for insurance adoption

Giulio Fusco*, Yari Vecchio**, Donatella Porrini*, Felice Adinolfi**

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Abstract

To achieve sustainability, agricultural insurance is one of the main tools capable of reducing the vulnerability of farmers. This is the reason it is important to investigate the different factors that affect the farmers' agricultural insurance decision-making. The paper, using Regional panel data from Italy Regions and the GMM dynamic panel data model, examines the effect of different group variables on agricultural insurance decision making: risk perception and management, agricultural insurance recognition, trust and affordability. The aim of this paper is: (1) to analyze, through a systematic literature review, which are the main problems regarding agricultural insurance diffusion, (2) to measure which category of variables influences agricultural insurance adoption, (3) to provide different policy solutions to improve the diffusion of agricultural insurance in Italy. The results show that agricultural insurance affordability, risk perception and management are the major influencing factors; a possible solution to improve the agricultural insurance demands would be to raise household net income and find an alternative solution to subsidies.

Keywords: *Agricultural insurance, Sustainability, Panel data, Decision-making, Italy.*

1. Introduction

The agricultural sector plays a key role in economic development and the reduction of poverty in the world (Christiaensen *et al.*, 2011). However, there are many threats to the agricultural sector, and one of the main ones is climate change and the consequent extreme events that have increased in recent years. In particular, climate change represents one of the major threats to agriculture, food security and livelihood of millions of people in many places (Field, 2014).

The damage produced by climate change has the potential to turn into disastrous and devastating situations for human communities in the absence of risk reduction systems (Beilfuss and Nhemachena, 2017). For this reason, it has become fundamental to develop an approach oriented to reducing vulnerability and to increasing resilience to disasters (Capitanio and Adinolfi, 2009; Speranza *et al.*, 2014; Javadinejad *et al.*, 2020a).

Based on this approach, hazard reduction pro-

* University of Salento, Lecce, Italy.
** University of Bologna, Italy.
Corresponding author: giulio.fusco@unisalento.it

grams should try to improve the resilience in communities through efficient risk management. Improving resilience represents one of the most important strategies to improve the adaptive capacity and sustainability in a system. In fact, resilience represents one of the most important factors in the realization of sustainability (Marta-Costa, 2010; Javadinejad *et al.*, 2020b).

Over the years, agricultural insurance is one of the most important tools to reducing farmers' exposure to yield and/or income risk (Mahul and Stutley, 2010), that derives from several risk factors, including adverse weather conditions, diseases and pests and other shocks of different nature. As a matter of fact, any event affecting global markets can lead to significant changes in the price of agricultural commodities (Chalise *et al.*, 2017). At the same time, the increase in the frequency and intensity of extreme weather events involves significant risks for farmers' agricultural production and incomes (Bielza Diaz-Caneja *et al.*, 2008; Vogel and Meyer, 2018).

The need to cover these risks is tied to the high degree of complexity that characterizes weather risks as evidenced by the extraordinary socio-economic concerns related to this kind of phenomena (Müller *et al.*, 2017). In detail, heavy rains, high temperatures and floods can cause huge losses if they occur when crops are vulnerable to such weather extremes (Matsuda and Kurosaki, 2019). In this scenario, agricultural insurance is acclaimed as a promising mechanism for resilience to climate extremes (Surminski *et al.*, 2016).

In this context, considering the direct relationship between the variability of production yields and the variability of weather conditions together with the growth of global demand for agricultural products, it becomes essential to have suitable tools to cover productivity losses (Burke and Emerick, 2016; Porrini *et al.*, 2019).

In the specific Italian case, over the years, the risk management policies in agriculture have undergone several changes with the aim of providing farmers with adequate risk coverage tools.

The public intervention for risk management in the agricultural sector in Italy began in 1970 with the establishment of the National Solidarity Funds (FSN). FSN have two distinct functions: to provide compensatory payments to farmers who suffered productivity losses for reasons not attributable to them; to facilitate taking out an agricultural insurance policy. Since the end of the 1990s, the European Community has been interested in the role of the agricultural insurance program (European Commission, 2001; European Commission, 2006; European Commission, 2011). Offering member states the ability to use part of the financial resources earmarked for direct payments to support farmers' access to insurance policies and mutual funds. But it is in 2013 with EU Regulation 1305/2013 that direct support is given to risk management tools, from then on the Member states can use up to 65% of the premium subsidies for agricultural insurance provided by insurance companies (Liesivaara and Myyrä, 2017).

In particular, one of the main policies was the Common Agricultural Policy (CAP) 2014-2020. The CAP 2014-2020 introduced a set of new policies that consist in an increase of the basic payment with additional allowance that the farmers receive when they decide to take out an insurance policy against the weather events (Cortignani and Dono, 2018; Garrone *et al.*, 2019).

Despite the presence of these instruments, among which subsidies, the percentage of area insured on the total utilized agricultural area (UAA) per region has never exceeded the rate of 31% (on average, 9%). The Italian agricultural insurance subsidized market manifested, in the period between 2015 and 2017, a clear sign of suffering, due in particular to the drop-in demand for insurance coverage against damage to crops and structured business (ISMEA, 2018). In 2017, according to ISMEA estimates, the insured values relating to crop yield amounted to 4.981 million euro, the lowest value since 2010. In 2017, a decrease of 5.8% was observed, compared to the decline of 5.4 % recorded in 2016. The entire amount of premiums was slightly less than 337 million euro, with a 4.5% reduction on an annual basis; while the average level of tariffs was 6.8%. We

can point out that same situation for premiums and the number of policies which registered, in 2017, the lowest value in the last five years (ISMEA, 2018). From these scenarios, it emerges that public policies for risk management have proved to be ineffective from the point of view of the diffusion of agricultural insurance.

The aim of this paper is to analyze the influencing factors of farmers' insurance decision-making, using panel data for the Italian Regions from year 2010 to 2017, in order to provide some economic policy suggestions to improve the diffusion of agricultural insurance in Italy. The choice to analyze the Italian context is related to the several changes that have characterized the agricultural insurance system in recent years (Di Falco *et al.*, 2014).

The principal novelty of this research is to empirically test if one of the main spreading policies of Italian agricultural insurance has a positive effect or not in the decision-making process of the Italian farmers (Santeramo *et al.*, 2018; Capitanio and De Pin, 2018).

Alongside the traditional variables used in the literature we include the variable total subsidies to see how this direct payment influences the decision-making process of farmers for the adoption of the insurance instrument (Miglietta *et al.*, 2020).

The article is organized as follows: section 2 is devoted to a literature review concerning agricultural insurance and the possible reasons for its insufficient diffusion. Section 3 presents the variables choice and the hypothesis construction. Section 4 reports the results and discussions of the study. Finally, Section 5 presents the conclusions and the economic policy implications in order to improve the diffusion of agricultural insurance in Italy.

2. Literature review

The reasons for insufficient agricultural insurance diffusion might be various and diverse. Many researchers have carried out studies from different perspectives (Raschky and Weck-Hannemann, 2007; Enjolras *et al.*, 2012; Lefebvre *et al.*, 2014; Pérez-Blanco *et al.*, 2016; Cole and Xiong, 2017; Fusco *et al.*, 2018).

Several authors have focused their attention on the feature of agricultural insurance products and their sub-theoretical definition. One of the main important perspectives analyzed in literature is the asymmetric information issue in the market of agricultural insurance. In particular, farmers have more information than the insurance companies, and for this reason the phenomena of adverse selection and moral hazard have lead to the continuous loss of insurers and their ultimate exit from the market. One of the first authors who analyzed this problem was Chambers (1989): he suggested asking insured farmers to share some of the losses (in this case the insurance companies would only pay a part of the loss). Another possible solution has been provided by Vercammen and Van Kooten (1994) they showed that requiring farmers to ensure crops over multiple years could reduce the moral hazard.

The asymmetric information problem in many cases can generate transaction costs that could increase the level of the premium and this aspect can explain the tepid interest for insurance (Knight and Coble, 1997). A different approach in analyzing the asymmetric information issue was proposed by Roberts *et al.* (2006): they tested the presence of moral hazard through a large set of administrative data. They departed from the earlier literature by examining the effect of insurance on output (yield) rather than inputs. Another contribution is the one by Yuanchang and Jiyu (2010) suggesting optimal boundary of the fiscal subsidies in agricultural insurance, in order to reduce loss due to asymmetric information and optimize the efficiency of fiscal transfers.

In this context, many authors identify the role of the State and the fiscal subsidies as a possible solution to reduce the asymmetric information issue and to increase the agricultural insurance diffusion. A brief introduction on the role of the government and the risk management policy was provided by Cafiero *et al.*, 2007. Several other studies have demonstrated that substantial subsidies are necessary to obtain even modest participation rates. In 2008, Garrido and Zilberman showed the effects of the subsidies on the Spanish agricultural insurance market; later, Luo

et al. (2014) used a similar approach to demonstrate how the Chinese farmers' willingness to pay is influenced by the level of subsidies. In this sense, Du *et al.* (2017), through a construction of expected utility maximization framework, analyzed the trade-offs between higher risk protection and larger subsidy payments.

The role of the subsidies is strongly linked with the willingness to pay concept and several studies have demonstrated this relationship and its importance. In fact, if the first studies demonstrated farmers' very low willingness to pay for yield or rainfall insurance (Smith and Watts, 2009), later studies have demonstrated other aspects which influence farmers' willingness to pay. Hill *et al.* (2013) analyzed the Ethiopian farmers' willingness to pay through a Probit model; the same analysis was conducted by Danso-Abbeam *et al.* (2014) for Ghana farmers, and by Liesivaara and Myyrä (2014) for Northern European countries. From all these studies we can affirm that the willingness to pay depends on different factors, i.e., the price of the insurance contracts, the level of education of the farmers, the household income and the level of the subsidies. The choice to purchase or not the agricultural insurance policies also depends on different conditions such as: economic, demographic and cultural factors (Smith and Glaubler, 2012; Abotsi *et al.*, 2014; Sihem, 2019).

Based on this evidence, we summarize the prior studies in Table 1. Specifically, we consider that the research on agricultural insurance is focused on different aspects such as: the asymmetric information issue, the willingness to pay, the level of subsidies, the role of the government and the factors affecting the market of the agricultural product.

Table 1 - Summary of the literature.

Author(s) (Year)	*Title*	*Area of study*	*Diffusion Problem*	*Aims of the study*
Chambers, 1989	Insurability and moral hazard in agricultural insurance markets	-	Asymmetric information, Moral hazard	The aim of this study is to analyze the effect of moral hazard on all-risk agricultural insurance indemnity schedules
Knight and Coble, 1997	Survey of US multiple peril crop insurance literature since 1980	USA	Asymmetric information, Moral hazard	This paper analyzes many issues related to the MPCI program with a significant focus on the U.S. farm policy debate since 1980. The purpose is to provide a survey of the literature reporting this kind of research.
Zhang and Gu, 2004	Quasi-public goods, external effect and the character of crop insurance—discussion about the theory of policy subsidy of crop insurance	-	Insurance as public-goods, Government aid	This paper analyzes the domestic and overseas literature on the subsidy policy failure in crop insurance market.
Sherrick *et al.*, 2004	Estimation of excess water use in irrigated agriculture: a data envelopment analysis approach	USA	Risk perception, Willingness to pay	This paper analyzes farmers' decisions to purchase crop insurance and their choices among alternative products. Using a two-stage estimation procedure to estimate the influences of risk perceptions and demographic differences.
Roberts *et al.*, 2006	Estimating the extent of moral hazard in crop insurance using administrative data.	USA	Adverse selection, Moral hazard, Government aid	In this paper, the authors test the presence of moral hazard through a large set of administrative data. They depart from the earlier literature by examining the effect of insurance on output (yield) rather than inputs.

Author(s) (Year)	*Title*	*Area of study*	*Diffusion Problem*	*Aims of the study*
Cafiero *et al.*, 2007	Risk and Crisis Management in the Reformed European Agricultural Policy	Europe	Government aid	The objective of this paper is to analyze the options that have been advanced by the European Commission to be able to contribute to academic and political debates on the role and effects of risk-related policies.
Chambers, 2007	Valuing agricultural insurance	USA	Asset pricing, Willingness to pay	The aim of this paper is to provide a method for estimating a discount factor that is independent form risk preferences. The results show that the stochastic discount factor is appropriate for calculating a farmer's willingness to pay for a crop insurance product.
Yuanchag and Jiyu, 2010	The optimal boundary of political subsidies for agricultural insurance in welfare economic prospect	China	Government aid, Asymmetric information	The article analyzes the optimal boundary of the fiscal subsidies in agricultural insurance, in order to reduce losses due to asymmetric information and optimize the efficiency of fiscal transfers.
Ramirez and Carpio, 2012	Premium estimation inaccuracy and the actuarial performance of the US crop insurance program	USA	Government aid	The purpose of this paper is to investigate the impact of the levels of inaccuracy associated with three different premium estimation methods on the actuarial performance of the US crop insurance program.
Smith and Glaubler, 2012	Agricultural insurance in developed countries: where have we been and where are we going?	World	Government aid, Willingness to pay, Moral hazard	The aim of the study is to analyze the development of crop insurance programs over the last fifty years in developed countries to identify their limitation sand the next step for agricultural insurance research.
Hill *et al.*, 2013	Adoption of weather-index insurance: learning from willingness to pay among a panel of households in rural Ethiopia	Ethiopia	Willingness to pay	In this article, the authors investigate which farmers would be early entrants into weather-index insurance markets in Ethiopia, considering the determinants of willingness to pay for weather insurance among 1,400 Ethiopian households.
Luo *et al.*, 2014	Incentives for promoting agricultural clean production technologies in China.	China	Government aid, Willingness to pay	This paper shows Chinese farmers' willingness to pay for environmental protection and accept compensation for potential losses of net income in relation to identified characteristics in China.
Danso-Abbeam *et al.*, 2014	Willingness to pay for farm insurance by smallholder cocoa farmers in Ghana	Ghana	Willingness to pay	This study analyzes the willingness to pay for cocoa price insurance in the Ghanaian cocoa industry using contingent valuation (CV) method.
Liesivaara and Myyrä, 2014	Willingness to pay for agricultural crop insurance in the northern EU	Europe	Willingness to pay	The purpose of this paper is to investigate the demand for crop insurance. Moreover, farmers' willingness to pay (WTP) for crop insurance is considered.

Author(s) (Year)	*Title*	*Area of study*	*Diffusion Problem*	*Aims of the study*
Abotsi *et al.*, 2014	Factors influencing risk management decision of small and medium scale enterprises in Ghana	Ghana	Risk management decision, Demographical factors. Economic factors	The aim of this research is to study the factors that enhance or preclude owners of SMEs in Ghana in making risk management decisions.
Feng and Hayes, 2016	Diversifying systemic risk in agriculture	USA, China	Government aid	The purpose of this paper is to investigate the possibility of converting systemic crop yield risk into "poolable" risk.
Du *et al.*, 2017	Rationality of choices in subsidized crop insurance markets.	USA	Government aid, Asymmetric information	Through a construction of expected utility maximization framework this paper analyzes the trade-offs between higher risk protection and larger subsidy payments. The authors examine the extent to which farmers' crop insurance choices conform to economic theory.
Fonta *et al.*, 2018	Estimating farmers' willingness to pay for weather index-based crop insurance uptake in West Africa: Insight from a pilot initiative in Southwestern Burkina Faso	Burkina Faso	Willingness to pay	The main purpose of this paper is to design a participatory methodology for farm households in Southwestern Burkina Faso on a new weather index-based crop insurance management initiative, through the analysis of the willingness to pay (WTP) of farm households.
Ngoc Que Ann *et al.*, 2019	Willingness to pay for agricultural flood insurance in the Mekong River Delta	Vietnam	Willingness to pay	The purpose of this paper is to analyze the willingness to pay of rice farmers for crop insurance by using a choice experiment.
Sihem, 2019	Economic and socio-cultural determinants of agricultural insurance demand across countries	USA, Europe	Socio-cultural factors	The aim of this paper is to identify the determinant factors in agricultural insurance adoption and to provide evidence that matters of religion, besides the socio-economic ones, played an explanatory role in demand for agricultural insurance in American and European countries in the period 2000–2012.

3. Materials and methods

3.1. *Analytic modelling*

The purpose of this paper is to analyze which factors influence the agricultural insurance decision of the Italian farmers. Following the methodological approach used in prior studies (Severini *et al.*, 2017; Garrone *et al.*, 2019; Jørgensen *et al.*, 2020), our analysis was performed through an empirical approach. Specifically, we used the Generalized Moment Method Dynamic panel data (GMM/DPD) through the latest version of the statistical software Stata, frequently used in econometrics analysis of panel data. In general, elements of dynamics in the panel models can be introduced assuming that the errors are AR processes by adding some delays of the dependent variable as regressors. Our sample was composed by the data of 19 Italian Regions from year 2010 to 2017. The adoption of macro

panel data could eliminate individual differences of macro samples and conserve the common factor of agricultural insurance.

To investigate the factors influencing agricultural insurance, the following econometric structure was used according to Liu *et al.* (2016):

$$Y_{i,t} = a + Y_{i,t-1} + X'_{i.t}\beta + \delta_i + \varepsilon_{i,t}, i = 1, \dots 19, t = 1, \dots 8$$

Where $Y_{i,t}$ is the dependent variable, which represents the extent or scale to which farmers translate their potential needs into real demand of insurance, $X_{i.t}$ represents the influencing factors, $\varepsilon_{i,t}$ indicates the effect of the ignored variables corresponding to individual difference, is stochastic error, reflecting the effect of those ignored variables that varies from cross section and time.

The inclusion of the delayed dependent variable in the regression model introduces a distortion that cannot be eliminated by a regression with fixed effect, and for the OLS estimator, not to be distorted, is necessary that each explanatory variable be uncorrelated with the error vector.

The common approach to deal with non-stationary data is to apply the first order difference to achieve a dynamic specification in raw differences and eliminate the individual effect, and get a new equation (Arellano and Bond, 1991; Arellano and Bover, 1995):

$$Y_{i,t} = a + \Delta Y_{i,t-1} + \Delta X'_{i.t}\beta + \Delta\varepsilon_{i,t}$$

Finally, in choosing instrumental variable (IV), usually, delayed dependent variables are effective instrumental variables. We obtained the instrumental variables in this way.

We built the optimum weighted matrix (Doornik *et al.*, 2002) and then we used it in a one-step Arellano-Bond estimation. Pulling out the residual in one-step estimation and computing, we obtained a white period covariance matrix and we replaced the weighted matrix with it.

Finally, we used this matrix in a two-step Arellano-Bond estimation and finally we obtained the parameters estimators.

3.2. *Variable selection and data*

Agricultural insurance decision-making is a continuous process of research, analysis of which factors can influence the farmer's final decision (Lyu and Barré, 2017; Eitzinger *et al.*, 2018).

In the analysis we used two different dependent variables indicating the extent or scale in which the farmers translate their potential needs into the real demand.

The first dependent variable is Agricultural Insurance Revenue (Y1): this variable indicates the total amount in € (euro) paid by the insured farmers on the basis of their insurance contracts (Liu *et al.*, 2016).

The second dependent variable is Certificates (Y2): this variable indicates the number of insurance contracts taken out against adverse events (Fusco *et al.*, 2018).

To improve agricultural insurance purchase, we analyzed the factors that affect insurance decision-making, and we divided these factors into different categories:

1) Risk perception and management variable

Farmer's subjective risk perception and risk probability are always inconsistent with the real risk probability. Under a specific threshold the farmers ignore this risk, trusting in the government relief, and do not purchase agricultural insurance policies; this behavior is called Samaritan's dilemma (Coate, 1995) or charity hazard (Miglietta *et al.*, 2020).

For this category, we selected the following variables according to Liu *et al.* (2016), Khataza *et al.* (2019), Deryugina and Kirwan (2018) and Asravor (2019).

a. Total Surface (TS): this variable indicates the total area measured in hectares (ha) destined to the cultivation of all types of crops. Normally, a greater surface corresponds to a higher production and consequently a higher loss in cases of climate change.
b. Machinery (MA): this variable expressed in € (euro), indicates the total amount of current upkeep cost of equipment and buildings. Higher upkeep cost could affect the farmers' capacity to manage agricultural risk.
c. Average household scale (HS): this variable indicates the average number of components per family for each Italian region.

This variable could be indicative of the farmers' ability to resist risk. If we suppose that the experience and the ability could be accumulated, households of higher scale could have more experience, ability and knowledge.

d. Total Subsidies (TS1): this variable indicates the amount of all subsidies on crops, including compensatory payments/area payments and set-aside premiums. The Italian agricultural insurance system is based on a national solidarity fund and agricultural insurance. Subsidies represent the main instrument to improve the diffusion of agricultural insurance.

2) Agricultural insurance recognition variable

Some studies have analyzed the farmers' educational levels in relation to the insurance choice, according to Akinola (2014) and Wang *et al.* (2016); we investigated this aspect using the following variables.

e. Farmers with a college degree or above (E1): this variable indicates the number of farmers with a college degree or above for each Italian region. The premise in this case is that to a higher level of instruction corresponds a better knowledge of the insurance system.

f. Percentage of farmers with secondary school or lower on the total farmers (E2): this variable indicates the percentage of the farmers with secondary school education or lower and the total number of farmers.

3) Agricultural Insurance trust variable

According to Boyd *et al.* (2011) and Zhan *et al*. (2019) farmers' insurance purchase is based on their trust in insurance companies, expecting that, when disaster occurs, they would get compensation is a relevant prerequisite for them to buy insurance.

g. Reimbursed Value (RV): this variable indicates the amount of money recovered by the farmers, after the adversities, thanks to the insurance contract, this variable is measured in € (euro).

4) Agricultural Insurance Affordability

According to Pérez-Blanco *et al.* (2016) and Luo and Luo (2017), one crucial factor that limits farmers' purchase of agricultural insurance is affordability. We analyzed this aspect with the following variables.

h. Farm net income (FR): this variable indicates, the net income of farmers for each Italian region expressed in € (euro). Farm net income could effectively indicate farmers' purchasing power.

i. Producer price index (PPI): this variable indicates the production price of agriculture products. This variable could affect farmers, in fact if we consider production product and agricultural insurance as two commodities under income effects, more consumption of one leads to less of the other.

Table 2 and Table 3 show the variables, the source of data and their summary statistics.

Considering the possibility of collinearity in the model, we conducted a correlation analysis between the independent variables (Mason and Perreault, 1991); their linear correlation is presented in Table 4.

From the results of the correlation matrix it is possible to affirm that the correlation coefficient between Reimbursed Value and Machinery is equal to 0.783, since there is not an economic link between the two variables, we keep the two variables in the model. We applied the same consideration for the correlation coefficient between household net income and machinery (Smith *et al.*, 2009).

Given that we decided to maintain these independent variables, we built the following regression models: in the first model agricultural insurance revenue (Y1) is a dependent variable and in the second model the dependent variable is the number of certificates (Y2):

$$(1)\quad lnY1_{i,t} = a + lnY1_{i,t-1} + \beta_1 lnTS_{i.t} + \beta_2 lnMA_{i.t} + \beta_3 lnHS_{i.t} + \beta_4 lnTS1_{i.t} + \beta_5 lnE1_{i.t} + \beta_6 lnE2_{i.t} + \beta_7 lnRV_{i.t} + \beta_8 lnRV_{i.t} + \beta_9 lnFR_{i.t} + \beta_{10} lnPPI_{i.t} + \varepsilon_{i,t}$$

$$(2)\quad lnY2_{i,t} = a + lnY2_{i,t-1} + \beta_1 lnTS_{i.t} + \beta_2 lnMA_{i.t} + \beta_3 lnHS_{i.t} + \beta_4 lnTS1_{i.t} + \beta_5 lnE1_{i.t} + \beta_6 lnE2_{i.t} + \beta_7 lnRV_{i.t} + \beta_8 lnRV_{i.t} + \beta_9 lnFR_{i.t} + \beta_{10} lnPPI_{i.t} + \varepsilon_{i,t}$$

Table 2 - Variables and data sources.

Denote	*Variables*	*Unit*	*Data Source*
Y1	Agricultural insurance revenue	€	ISMEA
Y2	Number of certificates	No.	ISMEA
TS	Total Surface	ha	ISTAT
MA	Machinery	€	FADN
HS	Average household scale	People per household	ISTAT
TS1	Total subsidies	€	FADN
E1	Farmers with a college degree or above	People per region	ISTAT
E2	Percentage of farmers with secondary school or lower on the total farmers	%	ISTAT
RV	Reimbursed Value	€	ISMEA
FR	Farmers' net income	€	FADN
PPI	Producer price index	€	ISTAT

Table 3 - Summary Statistics.

Variables	*Mean*	*Standard Deviation*	*Maximum*	*Minimum*
Y1	19,065,414	24,874,167.27	94,649,037	16,537
Y2	9,642	11,587.91	40,997	47
TS	630,939	414,234.48	1.621.970	47.046
MA	46,495,743	39,767,331	141,812,500	2,840,550
HS	2	0.16	3	2
TS1	10,363,047	12,249,213	62,558,640	14,420
E1	4,848	4,864.80	23,004	419
E2	58.18	11.82	75.32	26.11
RV	21,155,894	40,234,287.36	380,044,034	1
FR	898,791,814	675,168,500	2,736,529,280	120,172,720
PPI	111	2.23	114	107

Table 4 - Correlation analysis.

Variables	*TS*	*MA*	*HS*	*TS1*	*E1*	*E2*	*RV*	*HR*	*PPI*
TS	1,000	,141	,197	,093	,675	,074	,356	-,022	-,010
MA		1,000	-,401	,187	-,036	-,329	,783	,746	,052
HS			1,000	,092	,482	,294	-,268	-,569	-,034
TS1				1,000	,228	,000	,114	,167	-,251
E1					1,000	,061	,032	-,166	,000
E2						1,000	-,272	-,274	,000
RV							1,000	,657	,033
FR								1,000	-,132
PPI									1,000

3.3. *Hypotheses construction*

In this study, we considered how farmers' agricultural insurance decision-making is influenced by different factors and each variable could have a different effect on farmers' insurance choices. For each category, we built the following theoretical hypotheses:

Hypothesis 1: Risk perception and management variables; this category is composed of four variables. Total surface, Machinery and average household scale have a positive effect on agricultural insurance, while Total Subsidies has a negative effect, showing that in the Italian risk management agricultural system the charity hazard phenomenon exists.

Hypothesis 2: Agricultural insurance recognition variables; these variables affect the knowledge and the understanding of agricultural insurance system. Having a college degree or above has a positive role in the agricultural insurance diffusion while having secondary school or lower education has a negative effect.

Hypothesis 3: Agricultural Insurance trust variable; the variable Reimbursed Value has a positive effect, given that when a farmer receives a payment his confidence in the agricultural insurance system increases.

Hypothesis 4: Agricultural insurance affordability variables; these variables affect farmers' purchasing decisions, Household Net Income has a positive role, while Producer Price Index has a negative role.

4. Results and discussion

Table 5 shows the results of the GMM/DPP between dependent variable Agricultural insurance revenue and our independent variables.

Looking at the results, of the ten variables only one is insignificant, but the coefficient is consistent with the hypothesis. There are three variables with a high significancy level (p. value < 0.001) that are inconsistent with the hypothesis. In fact, farmers with college degree or above,

Table 5 - GMM/DPP results (dependent variable Agricultural insurance revenue).

Denote	*Variables*	*Coefficient*	*Significance*	*Consistent with Hypothesis*
Y1	Agricultural insurance revenue	0.517	***	
TS	Total Surface	0.238	**	Yes
MA	Machinery	0.769	***	Yes
HS	Average household scale	1.312		Yes
TS1	Total subsidies	−0.044	*	Yes
E1	Farmers with college degrees or above	−0.471	***	No
E2	Percentage of farmers with secondary school or lower on the total farmers	0.615	***	No
RV	Reimbursed Value	0.097	***	Yes
FR	Farmers net income	-0.191	*	No
PPI	Producer price index	-0.578	*	Yes
Summary Statistics				
AR (1) errors test		-2.041 [0.0413]		
AR (2) errors test		-0.54487 [0.5858]		
Sargan over-identification test		16.9566 [0.9104]		
Wald test		250538 [0.0000]		

*Note: *, **, *** stands for 10% 5% and 1% significancy levels respectively.*

Table 6 - GMM/DPP results (dependent variable Number of Certificates).

Denote	*Variables*	*Coefficient*	*Significance*	*Consistent with Hypothesis*
Y2	Number of certificates	0.948	***	
TS	Total Surface	−0.229	***	No
MA	Machinery	-0.127		No
HS	Average household scale	0.512		Yes
TS1	Total subsidies	−0.0240	***	Yes
E1	Farmers with college degrees or above	-0.033		No
E2	Percentage of farmers with secondary school or lower on the total farmers	0.464	***	No
RV	Reimbursed Value	0.043	***	Yes
HR	Farmers net income	0.240	***	Yes
PPI	Producer price index	-0.306	*	Yes
Summary Statistics				
AR (1) errors test		-1.64561 [0.0998]		
AR (2) errors test		-0.349679 [0.7266]		
Sargan over-identification test		12.3351 [0.9891]		
Wald test		1.56727e+006 [0.0000]		

*Note: *, **, *** stands for 10% 5% and 1% significancy levels respectively.*

percentage of farmers with secondary school or lower and farmers' net income present a high significancy level but the sign of the coefficient does not conform to our hypothesis.

For farmers with college and with secondary school degree our results are in disagreement with Akinola (2014). A possible explanation for this is that a farmer with a higher level of education knows better the advantages of public aid and for this reason decides to wait for public support. The result of the farmers' net income variable is in disagreement with the hypothesis construction; a possible explanation could be that when a farmer's income increases, the farmer pays a higher price according to Budhathoki *et al.* (2019).

The other independent variable signs confirm our hypotheses; we can affirm that there is a positive and significant relationship between Agricultural Insurance Revenue and Total Surface, Machinery and Reimbursed Value (Azadi *et al.*, 2019); while there is a negative relationship between Agricultural Insurance Revenue, Total Subsidies (Deryugina and Kirwan, 2018) and Producer Price Index variables.

In order to test the robustness of the results, we conducted the same analysis using as dependent variable Number of certificates, the GMM/DPD results are summarized in Table 6.

The results showed that, of the nine independent variables, three are insignificant (Machinery, average household scale, farmers with college degree or above), and only the coefficient of the Average Household Scale variable is consistent with the hypothesis.

The remaining six independent variables are significant under the 10% significancy level and their effect on the dependent variable is the same observed in Table 5, except for the Total Surface and Farmers' Net Income. For the Farmers' Net Income variable, we propose the same explanation as before; that is, when the Farmers' Net Income increases, they pay a higher price to

subscribe the insurance contract, but at the same time the number of insurance contracts increases, and these results have been confirmed by Budhathoki *et al.* (2019). The same explanation for the percentage of farmers with secondary school or lower variable; in fact, likely a farmer with a good level of education knows better the advantages of the public aid and for this reason decides to wait for public support.

The other independent variables are consistent with our hypothesis. There is a positive and significant relationship between Number of Certificates and Reimbursed Value and Farmers' Net Income and particularly an increase of 1% in the Farmers' Net Income generates a positive variation around 0.25% in the Number of Certificates. Furthermore, the analysis shows a close negative relationship between Total Subsidies and Number of Certificates variables and this result suggests that in the Italian agricultural system there exists the charity hazard phenomenon (Andor *et al*., 2020; Miglietta *et al.*, 2020).

5. Conclusion

In the study, we analyzed which factors influenced the process of agricultural insurance decision making. The major results that emerge are:

(1) According to Arshad *et al.* (2016), Fahad *et al.* (2018) and Dessart *et al*. (2019), agricultural risk perception and management affects farmers' agricultural insurance purchase. Moreover, year-end total rural power machinery, average rural household scale and government natural disaster relief have a significant effect in particular on the side of the agricultural insurance revenue.

(2) The charity hazard phenomenon exists in the Italian Agricultural Insurance system, an increase in the subsidies is not a valid instrument to face the agricultural insurance diffusion problem (Andor *et al.*, 2020; Miglietta *et al.*, 2020).

(3) Farmers' trust in insurance companies plays a role in their agricultural insurance decision-making, given that in the model, the reimbursed value is used to represent the trust variable (Zhang *et al.*, 2019).

(4) In the Italian agricultural insurance system there is not a positive relationship between a farmer's educational background and insurance diffusion. Our result is consistent with Black and Dorfman (2000), Velandia *et al.*, (2009) and Adjabui *et al.* (2019) who, in their studies found a negative relationship between education and crop insurance adoption, but contrasts with those who found a positive relationship between education and crop insurance (Sherrick *et al*., 2004; Olubiyo *et al.*, 2009; Cole *et al.*, 2013).

(5) Agricultural insurance affordability is an important factor in farmers' agricultural insurance decision-making. In fact, household net income boosts agricultural insurance purchase, in particular the number of certificates (Li *et al.*, 2017; Lyu and Barré, 2017; Liao *et al.*, 2020).

The theoretical implication of our paper is represented by the extension of the preliminary results collected by Liu *et al.* (2016), Shen *et al.* (2016), Deryugina and Kirwan (2018) and Budhathoki *et al.* (2019). In particular, similar to the preliminary results highlighted above, our results suggest that in Italy there exists the charity hazard phenomenon and that the agricultural insurance is a normal good.

The results of the study provide interesting insights into the role of the individual in the decision-making process of insurance policy adoption. The complexity component of the instrument highlights the importance of understanding the individual's perception (Vecchio *et al.*, 2020). This approach takes us away from the "rational actor model" of standard economics, in which the actor manifests autonomous and fixed preferences disconnected from the context (Kahneman, 2003; 2011; Markus and Kitayama, 2010; Hoff and Stiglitz, 2016). Perceptions, preferences and cognition are subjected to profound social and non-social influences (Di Maggio, 1997; Cialdini *et al.*, 2006) related to the context to which individuals have been exposed until that moment. As a matter of fact, the perception of complexity includes many facets that concern managerial, economic and social spheres.

As reported in many studies and confirmed in our results, the main barrier anchoring adoption of agricultural insurance is the economic one (Barnett and Mahul, 2007; Roesch-McNally *et al.*, 2018; Budhathoki *et al.*, 2019). This asymmetry between costs and benefits is an obstacle especially for small-medium farms, who have

less access to credit. Moreover, the possibility to cooperate, through organized structures such as consortia, favors collective action (Ostrom, 2010; De Rosa *et al.*, 2017), a key element to increasing the confidence to buy such protection tools (Zhang *et al.*, 2019). The consequent reduction of transaction costs to access development policies becomes fundamental, with the aim of supporting, also financially, the adoption of these instruments. In this, consortia should act as consultants in order to reduce the degree of perceived complexity (Gow *et al.*, 2002).

Based on previous considerations, this analysis offers some relevant policy implication. First of all, it provides us with a scenario of complexity that brings out the weakness of the insurance support scheme and therefore brings out the need for a new paradigm in order to sustain the adoption of insurance tools by farmers, as frequently emerges from literature (Miglietta *et al.*, 2020). In this sense, our results suggest that the identification of an economic mechanism could mitigate the phenomenon of the charity hazard. In particular, the provision of tax incentives and subsidies could be an effective way to increase the overall number of insured farmers. Moreover, it is important to boost investments to improve knowledge. The post-2020 CAP is, in fact, underlining the importance of knowledge to make the whole agri-food system more competitive and sustainable. To improve knowledge transfer, the entrepreneur's orientation process becomes crucial to promoting a more efficient managerial decision.

Finally, the managerial implication is represented by the need for insurance companies to identify new policies in order to increase the overall number of insurance contracts issued annually. In fact, the conjoint effects related to the increase of the weather risks represent a new scenario for insurance companies. In this sense, the identification of new policies could be an effective strategy to increase the demand of insurance by the farmers and guarantee the farms' survival (Kim *et al.*, 2020).

The limitation of our paper is represented by the absence of cross-country evaluation. In this sense, the future research could be addressed at filling this gap through the achievement of further results collected in other countries.

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