HOW TO TEST CHARITY HAZARD IN AGRICULTURAL INSURANCE SYSTEMS: EVIDENCE FROM THE ITALIAN CASE

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Abstract

With the term "Charity Hazard" we refer to the problem of crowding out of insurance by co-existing relief programs in the context of different institutional governmental disaster schemes. Recently the phenomenon of Charity Hazard has been considered in the agricultural sector as a consequence of the political interventions that provide for public economic aid discouraging the adoption of insurance. In this context, the purpose of this paper is to verify if Charity Hazard exists in the Italian agricultural insurance system, estimating panel data models for the period from 2004 to 2013 in the Italian regions. As a result, we found a negative relation between crop subsidies and the participation in the insurance programs demonstrating that in the Italian agricultural sector Charity Hazard plays a relevant role in the low level of diffusion of crop insurance policies.

Keywords: agricultural insurance; charity hazard; public subsidies

JEL: Q14, Q18, Q54, R28

1. Introduction

Charity Hazard is defined as the "*individuals' tendency not to insure or take any other mitigation measures because of the reliance on expected financial assistance from federal relief programs or donations by other individuals*" (Raschky and Weck-Hannemann, 2007).

Since years the Common Agricultural Policy (CAP) have focused on the target of enlarging crop insurance program in Europe (EU Regulation 1305/2013). In several countries in the European Union a national crop insurance schemes already exists, but the performance of these programs in terms of number of insured farms is still low. In some cases, such as Italy, participation in the programs remains insufficient in spite of significant subsidies to insurance premiums (Landini, 2015).

The poor diffusion of insurance corresponds to a missed opportunity to contribute to the general objective of sustainability and resilience: firstly, by providing policies covering claims by parties who allege damage (ex post recovery); secondly by introducing incentives for risk-reduction behavior (mitigation). So the reasons of the low penetration of crop insurance needs to be investigated.

Till now, reasons for such failures have been usually found in either supply or demand conditions. On the supply side, reasons could be asymmetric and incomplete information, adverse selection and moral hazard, and generally systemic risk. The systemic risk prevents crop insurers from achieving gains pooling individual risks since unfavorable events, such as droughts, simultaneously affect a large number of agricultural and generate a significant correlation among individual crop risks.

On the demand side, a reason could be the inability of farmers to assess precisely the benefits derived from agricultural insurances.

In this paper we would like to test if also the massive government intervention may negatively influence the decision to purchase a costly insurance policy as a consequence of the so called Charity Hazard effect.

In the next section we will define the background, first of all analyzing the literature on agricultural insurance, then Charity Hazard theory and specifically the case of Italian crop insurance system. In the third section we estimate a panel data model for the period from 2004 to 2013 in the Italian regions. The result is a negative relation between crop subsidies and the participation in the insurance programs demonstrating that in the Italian agricultural sector Charity Hazard is a reason of the low level of diffusion of crop insurance policies.

2. The background

2.1 Literature review on agricultural insurance

In analyzing the agricultural insurance literature, it is possible to divide it into two groups: one including the articles following a theoretical approach, another including the articles following an empirical one.

Following a theoretical approach, the seminal literature analyzed the causes of adverse selection and, in this contest, in 1986 Skees and Reed affirmed that the main problems are the relationship between insurance rate making and expected yields for individual farmers, and the bias introduced in coverage protection when trends are not used to establish expected yields.

Going in depth in this topic, Luo et al. (1994) observe a strong correlation between weather and climatic information and adverse selection in agricultural insurance, through an analysis conducted on the potential usefulness of seasonal weather information in predicting corn crops in the Midwest. In 2003, Kleindorfer and Klein introduced another agricultural insurance issue associated with the effective economic design of the disaster insurance markets and the regulation of private companies offering such insurance. Underlining how the inadequacy of the market to provide and disseminate the insurance instruments is greater in countries with lower income. Two studies showed that there is a close correlation between poverty and natural disaster and impacts produced by climate change on smallholder and subsistence agriculture emphasizing the need to identify a theoretical model able to understand the impacts produced and the necessary resources (Barnett and Mahul, 2007; Morton, 2007).

More recently, Aimin (2010) shows how climate change increases uncertainty and risk aversion in the people who work in the agricultural sector and the need to introduce risk management remedies; Ewert et al. (2015) seek to provide an overview on the current modeling of crops aiming at assessing the risks of climate change to food production. In the same year, Linnerooth-Bayer and Hochrainer-Stigler (2015) show how an overview of the disaster risk financing mechanisms could offset the reduction of disaster risk and the adaptation to climate change, especially in developing countries.

In analyzing agricultural insurance under an empirical point of view, one of the first was Hazell that in 1992, using insurance variables (premiums, administrative costs and indemnities) tried to compute the efficiency of private-sector insurance under public constraints.

Another empirical analysis was conducted by Smith and Goodwin (1996), that used different insurance variables, i.e. crop insurance, chemical input, premium rate, yields, farmers' believes, farmers' preferences, debt to asset ratio, crop acres, proportion of total farm sales derived from livestock sales, percentage of cropped dryland wheat acres rented by the farm, off-farm labor income, to demonstrate that dry wheat growers who subscribe crop insurance use less agricultural chemicals. Miranda and Glauber (1997), using an empirical model of the U.S. crop insurance market, find that U.S. crop insurer portfolios are twenty to fifty times riskier than they would be otherwise if yields were stochastically independent across farms. For this analysis, they considered the total indemnities paid by conventional insurance and the total indemnities paid by crop insurers.

In the following years, the relationship between the risk perceived by the farmer and the insurance was demonstrated, particularly in 1998 Just et al. in their study used the following insurance variables: low-price and high-price; in the following, Wall and Smit (2005) used agrometeoclimatic variables, such as climate risk and meteorological risk, to demonstrate the importance of developing climate-adaptive policies.

After that, recent literature gives greater importance to agrometeoclimatic variables. In particular, Rosenzweiga et al. (2014), considering CO_2 concentrations in the atmosphere, describe the response of crops to climate change, aiming at understanding the risks and opportunities in terms of food production and security. Shukla et al. (2015) demonstrate the role of temperature on the drought of

California in 2014 and show that this drought would have been less severe if temperatures resembled the historical climatology, and for the first time Lesk et al. (2016) try to estimate the national loss of cereal production due to extreme climatic disasters during the period 1964-2007 using drought, extreme heat, extreme cold and flood as variables of the analysis.

Partridge and Wagner (2016) focused on the need for adequate agricultural insurance schemes and identifies the lack of such schemes in South Africa, particularly for small farmers. The empirical analysis considers both insurance variables such as single risk, yield, price, whole-farm, revenue, income, index based and agrometeoclimatic variables such as storm, floods, droughts, wildfire, earthquakes. In the same direction, Fusco et al. (2018) measured the influence of climatic agrometeoclimatic variables on insurance variables, i.e. total premiums, insured value and certificates.

2.2 Charity Hazard theory

Lewis and Nickerson (1989) were among the first which translated into a formal model the idea that people underinsure because of the expected governmental assistance.

Raschky and Weck-Hannemann (2007) tried to understand why the damage caused in Europe by the floods of 2002 have not been adequately insured. According to them, the main reason was that individuals refuse to subscribe insurance cover against natural hazards is that they anticipated governmental and private aid.

Raschky (2008) through an empirical analysis of large-scale natural disasters between 1984 and 2004 emphasized how government actions affect human behavior and showed that countries with better institutions experience less victims and lower economic losses from natural disasters. In addition, the results suggest a non-linear relationship between economic development and economic disaster losses.

A concept closely interconnected to that of charity hazard is the Samaritan dilemma, which is based on a similar principle. Buchanan (1975) described the “Samaritan’s dilemma” as the case in which assistance to a person in need decreases the recipient’s incentives to improve the situation in the long run. In other words, when presented with charity people act using the charity to improve their situation, or coming to rely on charity as a means of survival. The phenomenon of Samaritan's Dilemma has been identified in the scientific literature as a consequence of producing disincentives through the provision of foreign aid (Gibson et al. 2005). Foreign aid is often paid in order to fill the financial gap between a required investment necessary to achieve a targeted growth rate and the available resources.

Raschky and Schwindt in 2008 discusses the impact of foreign aid on the recipient country's preparedness against natural disasters.

The recent literature focuses on the phenomenon of charity hazard, showing how it is one of the causes of inefficiency of coverage of damage caused by natural adversities.

Schwarze et al. (2011), using the case of Germany as an example, demonstrate that the obstacles to the insurance spread are numerous, including failure to recognize the role of state guarantees in enabling private insurance markets, mistaken legal objections against mandatory insurance, distributional conflicts between central and state governments and re-election considerations by politicians.

Raschky et al. (2013) discusses the problem of crowding out of insurance by co-existing governmental relief programs, as Charity Hazard effect, in the context of different institutional schemes of governmental disaster relief in Austria and Germany.

In 2014, Neumayer et al. estimated a quantile regression in a global sample, focusing on the three disaster types causing the vast majority of damage worldwide (earthquakes, floods and tropical cyclones), to measure the propensity to disaster in a country and the effectiveness of government action against natural disasters.

Osberghaus (2015) analyzed private flood mitigation measures among German households. The dataset covers more than 6,000 households from all parts of the country, this study observe the household behavior in respect to the expectation of government relief payments.

Recently the phenomenon of Charity Hazard has been considered as a consequence of the political intervention that disincentive the adoption of insurance. In this direction, the purpose of this paper is to verify the presence of Charity Hazard in a particular type of insurance, i.e. the Italian crop insurance.

2.3 The Italian crop insurance system

In Italy, in recent years, national policy to support risk management in agriculture has undergone major changes. In 1970, when government provided agricultural insurance, the system was based essentially on the establishment and financing of a national solidarity fund to compensate the damage suffered by farmers as a consequence of natural disasters, while the support for the payment of insurance premiums was secondary.

Public intervention for risk and crisis management in Italy started in 1970 with the creation of the National Solidarity Fund (FSN), which had two distinct functions: compensatory payments to farmers whose production capacity and income were reduced due to causes beyond their control;

and support for insurance policies. Access to ex-post compensatory payments was guaranteed to all farmers who suffered damage, regardless of whether or not an insurance contract was signed.

From 1981 until 2009, FSN expenditure amounted to 10 billion euros. Much of this expenditure was committed to compensatory payments in the event of natural disasters, while the remainder was to support for insurance policies. However, this expenditure was more than necessary with respect to ad-hoc policy interventions (Cafiero et al. 2006).

The system based on ex-post compensation for damage worked well enough in periods when the incidence of adverse events was sporadic, partly because the vulnerability of agricultural activities was lower. As the frequency of adverse weather events increases, this form of policy intervention has increasingly shown its limits, leading to distortions in business behavior. The result was that it discouraged the adoption of preventive actions by farmers and the uptake of insurance cover, increasing the overall cost to the community.

The government therefore decided to modify policy intervention in the management and prevention of risks in agriculture in Italy, in particular those concerning the management of damage caused by natural disasters.

Changes in legislation started in 2002, continuing in the following years, until reaching its peak in 2004 with a Legislative Decree. The main provisions allow for the possibility for (1) cooperatives to undertake contracts insurance, as already provided for defense consortia; (2) cooperatives to set up mutual funds for risk management and to receive support from public intervention at the same level as that provided by insurance companies, with public support for administrative costs; and (3) individual farmers to take out policies with insurance companies that are directly subsidized by the government.

The 2005 was the first year of full implementation of the reform of the subsidized insurance system in agriculture, with the provision requiring the insurance of all production of the crops covered in the policy, within the same municipality.

The policy is governed by the European regulatory framework. In this context, management autonomy is granted to the Member States, authorized to use up to 10% of their national ceilings for the provision of specific aid for clearly defined cases. In the EU regulatory framework the specific sources of aid are listed, and for insurance measures it is possible to use the first pillar (of the CAP) to subsidize measures to cover the risk of economic losses caused by adverse weather conditions and by animal diseases or plant diseases or parasitic infestations (Article 70, EC Regulation 73/2009). This measure allows the granting of financial contributions for the payment of crop insurance premiums up to a maximum of 65% of the total insurance premium, in the form of

Community co-financing, but this co-financing cannot exceed 75% of the national financial contribution.

At the Community level, there has been a long-standing debate on risk management and market crises. From the Commission proposal of October 2010, the purpose of which was to identify a range of support tools for managing income risk in agriculture (insurance and mutual funds), but does not outline the autonomy of Member States with regard to the implementation of public support for the same instruments. The expectations were for greater public involvement in support of mutual funds, with the novelty of relegating risk management funding within the resources of the second pillar of the CAP. This would have represented a new opportunity for individual Member States in the planning phase of expenditure and measures for post-2013 programming.

The 2010 policy was implemented within the 2014-2020 Common Agricultural Policy[1]. Under the overall guidance of the EU strategy Europe 2020, there are three strategic objectives in the CAP:

1. Sustainable food production, through increased competitiveness of the agricultural sector and the profitability of production;

2. Sustainable management of resources, to guarantee the production of public goods and the fight against the effects of climate change;

3. A balanced territorial development, to enhance differentiation agriculture and rural areas.

One of the main reasons to justify public support for insurance in agriculture - which takes the form of both the contribution to the payment of policies underwritten by farmers, and the benefits to companies in terms of reinsurance of the risks assumed - stems from the alleged failure of the private market to provide such insurance.

In so far as public intervention would reduce market failures, it would increase overall efficiency, allowing the market to offer a service for which there would be a demand, as it has the potential to address information asymmetry caused by systemic risk, adverse selection and moral hazard, as stressed by Cafiero et al. (2006).

Figure 1 shows the ratio between compensated claims and premiums paid both at national and provincial level (the loss ratio) in agricultural insurance in Italy. The loss ratio at national level is always less than unity and ranged between a maximum of 82 % in 2008 and a minimum of 56% in 2006.

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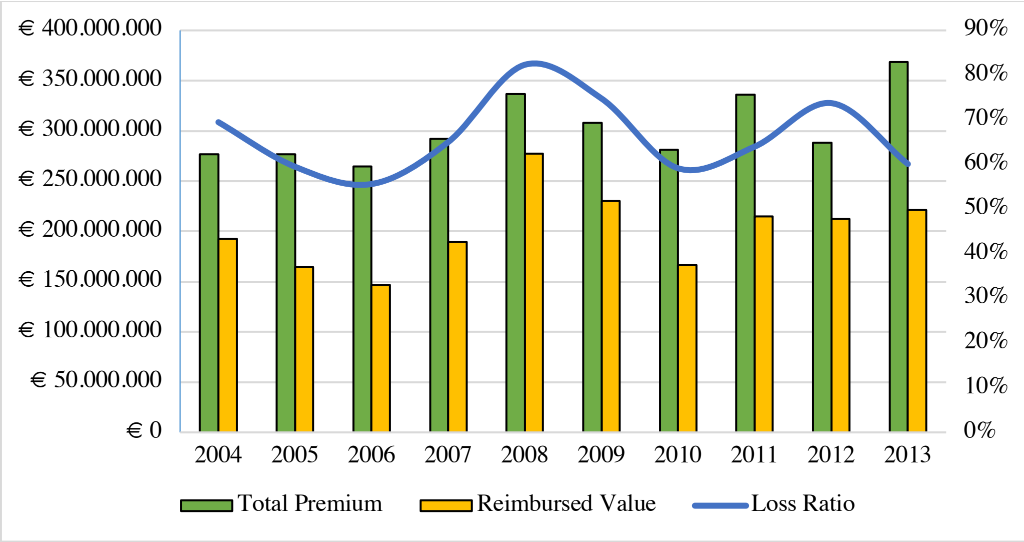
[1] The financing of the CAP is provided through two funds: the FEOGA (European Agricultural Guarantee Fund) and EAFRD (European Agricultural Fund for Rural Development). The two funds are intended to guarantee different treatment targeted to the different objectives of the CAP, but both funds apply the same rules as far as possible, for example in paying agencies and liquidation procedures in the accounts.

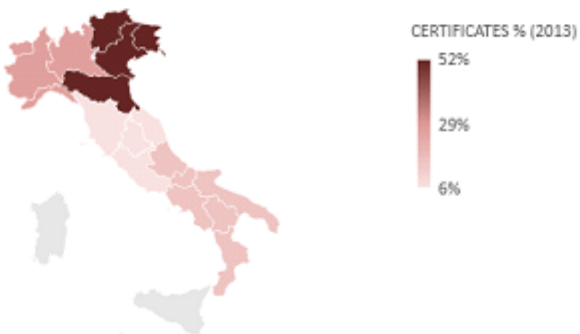
Figure 1 - The evolution of the insurance system in Italy 2004-2013



Source: SICURAGRO

Figure 2 describes the spatial distribution of agricultural insurance in Italy. The data shows that almost all the insurance certificates issued are located in the north, with 52% in the north-east and 27% in the north-west, whereas in the south and in central Italy, they are not very common, accounting for just over 20%. This disparity across regions illustrates the different value of the agricultural production.

Figure 2 - Geographical distribution of agricultural insurance in Italy



Source: SICURAGRO

3. The empirical evidence

In recent decades, large part of the literature about agricultural insurance, as we has seen above, has asserted that without subsidies no farmers would insure themselves, but the use of a targeted system, with costs charged to farmers, can lead to a reduction in the negative effects of moral hazard and political failure.

In assessing the Italian system, it is necessary to take into consideration aspects related to systemic damage and adverse selection. However, those related to moral hazard, concerning the behavior of individual farmers, can't be taken into account, given the incomplete information available.

Systemic damage occurs when a large number of insured persons are simultaneously damaged by an adverse event affecting a geographical area. It is a problem considered typical for agricultural insurance due to adverse weather events, which, by striking relatively large areas, cause simultaneous damage to a large number of farms. The systemic nature of the damages means that it is possible to distribute risks among the group of insured persons in the absence of spatial correlation of adverse events.

3.1 Data and methodology

We utilize data on precipitation, average, maximum and minimum temperatures for the 2004-2013 period for each Italian Region extracted from the National Agrometeorological Database of the Minister of food, agricultural and forestry policies which contains agrometeoclimatic data (MIPAAF, 2017).

In particular, the Precipitation variable refers to the average annual quantity of rainfall measured in millimeters (mm). Average Temperature indicates the average annual temperature retrieved in each Region on a daily basis. Data on Maximum Temperature and Minimum Temperature, expressed in Celsius degrees (°C), indicates respectively the average value of highest and lowest annual temperatures retrieved by the agro-meteorological stations in each Italian region.

Data on phytosanitary product utilization and total cultivated surface for the same time window in the same Italian Regions have been acquired from the Italian National Statistics Institute (ISTAT). Total cultivated surface measures the total hectares (ha) of an area destined to cultivation of all types of crops. Phytosanitary utilization refers to the quantities expressed in kilograms (kg) of active substances or active ingredients distributed during the cultivation process (ISTAT, 2017).

Data about the total subsidies on crops have been extracted from the Farm Accountancy Data Network (FADN), provided by Agricultural and Rural Development. The total subsidies on crops variable indicate the amount of all subsidies on crops, including compensatory payments/area payments and set-aside premiums, indicated with the code SE610 in the database (FADN, 2017).

Figures regarding the certificates, insured value and total premium for the same time period, aggregated for each Italian Region, have been acquired from the Database on Agricultural Hazards (SICURAGRO), established by ISMEA, aiming at supporting public intervention for agricultural risk management and providing informative elements for shareholders, also for the purpose of risk prevention. The certificates variable indicates the number of agricultural products insured against atmospheric adversities. The insured value represents the value of insured agricultural products expressed in thousands of euro (1,000 €), against adverse weather conditions. The total premium indicates the amount in thousands of euro (1,000 €) paid by the insured farmers on the basis of subscriptions (ISMEA, 2017)

Table 1. Data sources and summary statistics

Source	Data acquired	Mean	Standard deviation	Minimum	Maximum
MIPAAF	Precipitation (mm)	826.62	179.60	406.00	1,337.70
	Medium temperature (°C)	13.28	3.09	4.20	19.10
	Minimum temperature (°C)	8.59	3.24	-0.61	15.20
	Maximum temperature (°C)	17.90	3.12	8.50	23.00
FADN	Total subsidies on crops (1,000 €)	2,131.36	5,533.7	0,00	28,590.16
ISTAT	Phytosanitary product (kg)	7,640,990.30	6,457,988.75	408,372.00	21,995,272.00
	Total cultivated surface (ha)	650,571.97	422,630.320	48,827.46	1,640,411.91
	Agricultural production (q)	30,014,064.68	26,152,893.23	925,578.00	129,979,177.00
	Labor force (1,000 workers)	49.98	35.94	6.85	140.48
ISMEA	Certificates (no.)	13,026.81	18,319.75	83.00	93,200.00
	Insured Value (1,000 €)	287,703,634.82	384,931,654.62	4,560,912.00	2,128,792,376.38
	Total Premium (1,000 €)	22,714,340.52	63,892,217.69	119,852.22	771,510,480.68

Before proceeding to the specification of the models to be submitted to regression analysis, having our data an important temporal dimension (10 years), we investigated the possible presence of trends in the variables and their nature (stochastic or deterministic).

Previous studies have analyzed the effects of agro-climatic variables on agricultural production, using dynamic fixed effects models (Tokunaga et al., 2015), but also on insurance aspects, using pooled OLS regression (Fusco et al., 2018). The most widely used econometric structure to investigate the effects of subsidies on insurance certificates is as follows:

$$y_{i,t} = \alpha + \beta y_{i,t-1} + \gamma Prec_{i,t} + \delta Prec_{i,t-1} + \vartheta T_{i,t-1} + \rho Z_{i,t-1} + \omega Subs_{i,t-1} + \varphi Geog_i + \mu_i + \lambda_t + \varepsilon_{i,t} \tag{1}$$

where $y_{i,t}$ is an insurance variable (in our case it is represented by the certificates, i.e. the number of agricultural products insured against atmospheric adversities; the insured value; the total premium); $Prec_{i,t}$ and $Prec_{i,t-1}$ refer to the annual average quantities of rainfall measured in millimeters (mm) in a Region i, respectively one and two years before the year in which certificates y are subscribed; $T_{i,t-1}$ is the vector of the temperature variables of each Region i and at time $t-1$; $Z_{i,t-1}$ represents the vector of the agro variables of each Region i and at time $t-1$; $Subs_{i,t-1}$ are the total subsidies received by farmers in each Region i and at time $t-1$. $Geog_i$ is a dummy variable which assumes value 0 for the Regions located in the Southern Italy and the islands (Sicily and Sardinia) and value 1 for the regions whose geographical location is the North of Italy.

y is the parameter of interest which captures how the observed insurance variable acts in relation to the subsidies. Finally, μ_i e λ_t are respectively regional fixed effects and time fixed effects, while $\varepsilon_{i,t}$ is the error term.

The inclusion of the delayed dependent variable in (1) introduces a distortion in the model that cannot be eliminated by a fixed effects regression. The OLS estimator, to be non-distorted, requires that each explanatory variable (formalized as a vector column of observations) must be uncorrelated with the error vector. In equation (1) this assumption is violated because the delayed dependent variable vector $\overrightarrow{y_{\imath-\jmath}}$ is correlated with the vector $\overrightarrow{\varepsilon_\imath}$. For a given Region i, the t^{th} element of the vector $\overrightarrow{y_{\imath,-1}}$, $y_{i,t-1}$ and the $(t-1)^{th}$ element of the vector $\overrightarrow{\varepsilon_\imath}$, $\varepsilon_{i,t-1}$, are correlated in equation (1).

The common approach to dealing with non-stationary data is to apply the difference operator in order to achieve a dynamic specification in raw differences. The equation to be estimated will thus take the form:

$$\Delta y_{i,t} = \alpha + \beta \Delta y_{i,t-1} + \gamma \Delta Prec_{i,t} + \delta \Delta Prec_{i,t-1} + \vartheta \Delta T_{i,t-1} + \rho \Delta Z_{i,t-1} + \omega \Delta Subs_{i,t-1} + \varphi Geog_i + \mu_i + \lambda_t + \varepsilon_{i,t} \tag{2}$$

In equation (2) we applied a transformation into raw differences both to the dependent variable and to all the regressors, excluding the geographical variable, initially measured in level. Applying the raw differences the regional fixed effects are eliminated, but not the temporal fixed effects.

The inclusion of the delayed dependent variable between regressors often eliminates the problem of serial correlation with the error term, but it introduces in the regression model potential distortion due to the disappearance of the hypothesis of strong exogeneity of the error term $\varepsilon_{i,t}$.

In order to correct this distortion, Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998) developed estimators based on the generalized moments method, for regressions with dynamic panel data. The underlying idea is to find an instrumental variable for equation (2) that is correlated with $\Delta y_{i,t-1}$ but not with $\Delta\varepsilon_{i,t}$.

Arellano and Bond (1991) show how, under the hypothesis that the error term $\Delta\varepsilon_{i,t}$ is not serially correlated, the value of the dependent variable, delayed by two or more periods, satisfies these requirements and could be used as an instrument for $\Delta y_{i,t-1}$.

As analyzed in the literature, the distortion of this formulation is of order $1/t$, even if the number of territorial units (in this case the Italian Regions) becomes large. The distortion of the fixed effects estimator thus decreases only if $t \rightarrow \infty$ (see, among others, Nickell, 1981; Kiviet, 1995).

The fixed effects estimator is distorted but consistent, but we believe that it is not the most suitable method to apply in our case. Although the GMM estimator (based on the equation in raw differences) provides consistent estimates, Arellano and Bover (1995) and Blundell and Bond (1998) show how, on the basis of statistical simulations, this estimator has poor precision in finished samples.

The insight behind it is that when the explanatory variables are persistent over time, the delayed values of these variables are weakly correlated with the differences of these variables in the differentiated regression equation. In order to increase the accuracy of the estimates, Arellano and Bover (1995) and Blundell and Bond (1998) propose to combine the differentiated regression with the original regression in level.

The tools for regression in differences are those previously described, while the tools for regression in level are the delayed values of the differentiated dependent variables. The disadvantage of this last estimator is that it reduces the sample size due to the sensitivity of the internal instruments (the delayed explanatory variables), moreover, its properties in small samples are generally unknown.

The estimator of Arellano and Bond (1991), as a first step, transforms all regressors through differentiation and uses the generalized method of moments, it is therefore called Difference GMM.

The estimator of Arellano-Bover (1995) / Blundell-Bond (1998) constructs a system of two equations, the original equation and the transformed one, which is therefore called System-GMM.

Both GMM estimators provide consistent panel estimates where t is small and N is large. We therefore believe that the use of these two estimators for dynamic panel data is consistent with the characteristics of our data and much more appropriate than the fixed effects estimator.

Our panel data models are estimated considering the period from 2004 to 2013 for the 19 Italian Regions (excluding Valle d'Aosta because of the lack of insurance data) in which reliable data exist for the phytosanitary product, precipitation, medium temperature, maximum temperature, minimum temperature, total cultivated surface, agricultural production, total subsidies on crops, certificates, insured value and total premium.

3.2 Results

Columns labeled (1), (2), and (3) included below in Table 3, report the results of the three-separate dynamic panel model analyses. It is important to underline that, in our dynamic panel models, variables do not act at the same temporal level, some independent variables refer to $t-1$ period, while the dependent variables refer to the time t.

Table 3. Results of the Dynamic Panel Estimation based on SYS-GMM

	Ln *Certificates* **(1)**	Ln *Insured Value* **(2)**	Ln *Total Premium* **(3)**
Ln *Certificates* $_{t-1}$	0.2091*** 0.0765		
Ln *Insured Value* $_{t-1}$		0.9203*** 0.0929	
Ln *Total Premium* $_{t-1}$			0.2781 0,1875
Ln *Prec* $_{t}$	–0.2361* 0.1355	–0.0850 0.0654	0.4441** 0.1768
Ln *Prec* $_{t-1}$	–0.4297** 0.1919	–0.2872*** 0.0762	–0.5761*** 0.1835
Ln *Subs* $_{t-1}$	–0.0336** 0.0142	–0.0042 0.0046	–0.0080 0.0111
Ln *TotSurf* $_{t-1}$	–0.2264** 0.1128	–0.0891** 0.0397	0.1327 0.1488
Ln *Phyto* $_{t-1}$	0.7945*** 0.1193	0.1265* 0.0724	0.5784*** 0.1779
Ln *Tempaverage* $_{t-1}$	–5.5585** 2.6193	–0.0972 0.6635	–3.1536 2.1071
Ln *Tempmin* $_{t-1}$	0.3053** 0.1331	0.0280 0.0364	0.2884** 0.1281
Ln *Tempmax* $_{t-1}$	3.6949 3.0901	–0.3233 0.6900	0.1608 1.8157
Geog	0.0734*** 0.0112	0.0081 0.0074	0.0745*** 0.0229
AR (1) errors test	-2.6166 [0.0089]	-3.0876 [0.0020]	-1.37375 [0.1695]
AR (2) errors test	-1.1913 [0.2336]	-2.0345 [0.0419]	-0.0338321 [0.9730]

Sargan over-identification test	12.9189 [1,0000]	16.9454 [0.9999]	14.1462 [1.0000]
Wald test	902.306 [0,0000]	11895.3 [0.0000]	8045.62 [0.0000]

The values in the table are the coefficients, standard errors (in parentheses), their p-values, and summary statistics, as indicated by the description in each row.

The SYS-GMM results (1) consider the relation between the dependent variable Ln *Certificates* and the independent variables. The analysis demonstrates the significance of Ln *Prec* $_{t-1}$, Ln *Phyto* $_{t-1}$ and Ln *Tempmin* $_{t-1}$ variables, in particular the presence of lower precipitation and higher minimum temperatures implies an increase in the value of the dependent variable. A positive variation of 1% in the precipitation variable originates a consequent negative variation of 0.3% in the number of certificates registered the subsequent year.

Notwithstanding, since the aim of this study is to test the existence of the charity hazard phenomenon in the Italian agricultural insurance system, the effects of subsidies on insurance certificates has to be properly interpreted. Results highlight a negative relation between the number of subscribed insurance certificates and the amount of subsidies received by farmers in each Italian Region. In particular, a positive variation of 1% in the total subsidies received generates a negative variation (about -0.34%) in the number of insurance certificates subscribed by farmers in the subsequent years.

SYS-GMM results (2) consider the relation between the dependent variable Ln *Insured Value* and the independent variables and highlight almost the same effects of those in column (1). In this case, the Ln *Subs* $_{t-1}$ variable is not significant. This result underlines how the amount of subsidies strictly affects the number of subscribed insurance certificates, but not their insured value.

SYS-GMM dynamic panel estimation (3) use instead the Ln *Total Premium* as dependent variable helping us to establish whether the tested analyses is robust. Results (3) confirm those previously analyzed. In the presence of lower precipitation and high minimum temperature the premium paid increases and that the subsidies variable is not significant, confirming its effect only the number of subscribed insurance certificates.

4. Conclusions

This paper provides the estimate of a negative relation between crop subsidies and the participation in the insurance programs in the Italian agricultural sector, demonstrating the existence of charity hazard.

The disincentive and crowd-out effects of public aid on the choice of buying a crop insurance policies ends up in Italy to be a relevant factor for the low level of penetration of the crop insurance.

Recent developments indicate that risks faced by European farmers will be increasing: greater exposure to global markets and emerging new risks such as those linked to climate change, e.g. higher frequency of extreme weather events. The current CAP proposes a quite detailed system for managing risks, through a set of tools, complemented by a number of private and national tools. However, in some countries the implementation of such a tools remains unsatisfactory,

In the belief that the diffusion of insurance can contribute to general objective of sustainability and resilience, it is necessary to implement alternative solutions to subsidies.

An effective policy could be the introduction of a mandatory insurance against adversities, which would eliminate Charity Hazard phenomenon and the informational asymmetries. Another alternative could be to eliminate government aid and concentrate those resources on financially supporting a more effective tool that captures also geographical diversity, e.g. the different social structure between North and South of Italy.

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