ON INSURANCE TO EXTREME EVENTS AND FARMERS WELFARE: PANEL DATA EVIDENCE FROM ITALY

Fabian Capitanio*, Salvatore Di Falco **, Felice Adinolfi***

Abstract

This paper aim to understand the viability of the insurance schemes via estimating both the underlying factors that determine farmers decision to adopt an insurance scheme against extreme events and the implications in terms of welfare. It uses a very rich farm level panel data from Italy. We have access to information regarding more than 8500 farms followed for 4 years and adopt a comprehensive estimating strategy that controls for the potential endogeneity of the insurance variable. The econometric results show that the insurance is positively correlated with welfare (captured by farm revenues). We also find that farms that have more crop diversification are more likely to adopt the insurance scheme. This may indicate that crop diversification may act as complement for financial insurance and not as substitute.

Keywords: agriculture, risk management, Italy, extreme events, econometric results, insurance, empirical strategy, farmers

** University of Naples Federico II – Italy. Fabian Capitanio, via Università, 96 – 80055 Portici (NA), Italy, capitani@unina.it, tel. +39 0812539056, fax +39 0817755143*
*** London School of Economics – UK*
**** University of Bologna – Italy*

Introduction

Agricultural production is strongly dependent on the natural and climatic conditions of the agro-ecosystem. Agriculture production is characterized by factors that are outside managers' control These circumstances translate in a high degree of risk regarding the economic performance of farm.. This is one of the main reasons why public intervention in the agricultural sector has been seen as vital for farmers' welfare. The intervention, for instance, aimed at reducing income variability has no parallel in other sectors of the economy. The implications for farmers' welfare under risk are the result of both the characteristics of the random events and of the complex set of public and private actions. These actions can be taken both ex-ante and ex-post and they form the basis for guiding the design of a comprehensive policy framework. As a result, a large number of strategies and tools have been developed to help farmers in making choices in presence of risk exposure. At the same time, the regulators via the implementations of both social and sectoral policies, have attempted to reduce the extent and cost of risk exposure. Mostly developing support measure that would help risk mitigation. While this is relevant, it opens up the possibility that public actions might affect, or crowd-out, existing farm risk management strategies, e.g. farmers' diversification (Wright, B. D. e J. A. Hewitt, 1994).

Specifically crop yield and quality, and farmers' revenue, usually are considered rather volatile due to a series of stochastic weather related factors determining crop growth. That is, farmer activities are directly affected by temperature and precipitation. The nature and character of these effects and reactions to specific conditions are crop specific and are strongly interrelated.

The increased frequency of extreme events (i.e. hailstorm, droughts) encapsulated by climate change may stress this issue further. Projected general weather changes for Mediterranean area are clear but their magnitude however is not. Warming is expected to increase both winter and summer seasons hence affecting production. Increased CO2-concentrations may directly enhance crop productivity while increasing water use efficiency. In severe cases, however, a substantial impact on famers 'welfare (i.e. farm income) can be expected as a result of more adverse weather conditions. The extent of this will depend on factors including crops cultivated, soil type (including texture, drainage), potentials for irrigation and risk behavior.

The impact of changed risky prospects cannot be assessed without considering the potential impact on the whole portfolio of farm-specific risky prospects. Given the importance of weather conditions for crop yield, selection of a proper management and coping strategy for changing climate and weather conditions is essential. Recent extremes, such as the summer of 2003 (Schär et al., 2004) with estimated losses in the agricultural sector of around 12 billion US$ in Europe (Swiss RE, 2004), stresses the importance of climatic extremes. As incidence of weather-induced extremes is expected to increase, changes in crop management will be needed. This has been captured by a series of agronomic studies on the implication of climate on farm productivity (Reilly et al., 1994; Rosenzweig and Parry, 1994; Gregory et al., 1999; Fuhrer, 2003). Farmers can implement minor adaptations such as changes in sowing date introducing new crops and cropping patterns. Alternatively, they can implement investment decision (i.e. irrigation). Farmers can also rely on financial support provided by insurance market via crop insurance.

In recent years, the market for insurance for extreme events (or catastrophic risk) has considerably grown and the insurance, reinsurance and financial markets contribute now to hedge more natural hazards than ever (Froot, 2001). Structural reform of the United States' subsidizations, for instance, has been particularly important for the agricultural sector. The aim of the reform is indeed the introduction and the development of private insurance and the encouragement for a multirisk approach. According to recent surveys with large French insurance companies, this stake is by far the most important in financial terms. It also uniformly concerns all types of activities, including agriculture. We note that there is a large body of literature on this subject (Choi and Weiss, 2005;Grace et al., 2004; Lustig and Van Nieuwerburgh, 2005).

If we consider the catastrophic (or extreme events) insurance problem from the farm's standpoint, we should notice that the most studied criterion is their solvency. In this area, the existing literature mainly refers to insurance companies (Zanjani, 2002, Kelly and Kleffner, 2003). Natural hazards are an important preoccupation of agricultural producers. They may benefit from a goverments' intervention in most developed countries as a coping mechanism (after that a bad event occurs). However, this seems to be not always desirable and it comes with a cost to the society. A cost that governments may not be willing or able to cover in the future. Specially, if extreme events will become more and more frequent. Previous researches mainly refer to the United States (for instance, Knight and Coble, 1997). This country has developed overtime (in 1980, 1994 and 2000) a stronger crop insurance system (Glauber, 2004). Nevertheless, some countries of the southern European Union have also successfully developed integrated insurance programs (Garrido and Zilberman, 2007). Nowadays, in these most advanced systems, insurance policies subscription reaches about 50% to 60% of eligible farms.

This paper seeks to contribute to these different strands of literature, by providing empirical evidence of the determinants of the decision to insure and its implications on farmers' welfare. We build up from the literature on the impact of climate change on agriculture literature (Mendelsohn et al, 1994). Thus we specify an equation where farm revenues are regressed against weather variables. We extend the model To this end we adopt a two step estimation approach. Data are drawn from a very rich panel data form Italy. We have access to 8500 farmers from 2004 to 2007 (more than 25000 observations).

Backgrounds

Much of the attention that risk management instruments and policy have received in recent years both in the US and in Europe is possibly due to the introduction of two articles in the WTO´s agreement for the agricultural sector. This was signed in the Uruguay Round Agreement on Agriculture (URAA), specifically at the articles 7 and 8 of Annex II, which listed government financial participation in income insurance program or income safety net and payments for relief from natural disaster among the types of support exempted from the domestic support reduction commitments, thus effectively allowing their continuation. The eligibility criteria listed in the URAA are rather ample, in that compensations of up to 70% of the losses are admitted for income losses of at least 30% of the preceding three years' average, which caused most existing disaster assistance and financial participation to crop insurance programs to be promptly marginally redefined to comply with these norms. The Italian case is particularly interesting because, as in Spain, United States and Canada, Government is heavily involved in subsidizing crop insurance and in guarantee ex-post payments in case of disaster. In Italy, Government's involvement in agricultural risk management is based on the fully publicly financed *Fondo* di *Solidarietà Nazionale* (FSN), set up in 1974 with two main objectives: to compensate farmers suffering from damages due to natural disasters and to support the use of crop insurance.

Until recently, access to disaster payments was open to all farmers, irrespective of the signing of insurance contracts. From 1981 through 2002, appropriations by FSN have reached about €7.2 billion; 72% of the amount spent has been directed to disaster payments, while insurance subsidies have absorbed the remaining 28%. Over the same period, disaster payments averaged €225 million per year, reaching a maximum of €522 million in 1990. The Italian system of compensation of natural disaster damages is mainly reactive, in the sense that the initial yearly endowment of funds received by the FSN can be integrated with ad hoc specific legislative measures, when necessary In 2002, the total appropriations for the FSN have been €481 million. (Borriello, 2003).

The law which established the FSN also authorized operation of farmers' associations at the provincial level (Consorzi di Difesa) which were assigned two functions: (i) collection of farmers' insurance demands (mainly for hail) and transferring them to the insurance companies; (ii) coordination and enforcement of common preventive measures.

Insurance contracts channeled through the operation of the *Consorzi di Difesa* could benefit of premium subsidies of up to 50%, although the raise in market insurance premiums led to a change in the legislation, in 19 that caused the effective subsidies to The mutual approach was intended to reduce the problems of asymmetric information and to improve power relationships in fixing insurance premiums. Despite subsidies of about 35% to 40% of actual premiums, the diffusion of insurance in the Italian agriculture has been rather weak: the share of insured value on total crop production -mainly fruit crops and vineyards- has never been more than a maximum of 15%, reached in 1998 and decreased in the following years. One likely reason is the possibility for Italian farmers to access compensations for natural disaster even without the signing of insurance policies.

The Italian system has been modified in recent years with more emphasis on crop insurance, in an attempt to reduce the cost of ex-post compensation in case of disasters. The main changes are the possibility for farmers to underwrite newly designed contracts for innovative multiple-peril[39] coverage directly with insurance companies, with subsidy to premiums up to 80%, and publicly supported reinsurance.

In this paper, we consider the problem on a national scale in order to get a representative overview of the situation. This approach is facilitated by the data of the Farm Accountancy Data Network (FADN-RICA). We provide more details on the following paragraphs.

[39] Until 2004, the only crop insurance contract sold in Italy has been the hail insurance.

Data

As we already pointed out in the introduction, the experimental scheme of this paper allows examining major concerns about the main determinants to insurance decision that lead farms to insure against crop risk. To answer these questions, we detail in the followings subsections our variables and the main assumptions of our model.

The study uses a survey of farmers in Italy belonging to the Farm Accountancy Data Network - RICA (FADN). Data are accounted for each year from a representative sample of farms, whose size can be considered as commercial. Within the original database, we only select farms that have continuously appertained to the sample from 2004 to 2007. Finally, our sample includes roughly 8,500 farms. In the following subsections, we detail the main explanatory variables that enter in the analysis. We choose to detail a wide range of potential factors including financial and meteorological variables, often missing in the literature. For the purpose of our analysis, we selected a variable indicating the eventual subscription of a private crop insurance policy. This can be found only for the years 2004 to 2007, which delimitates our temporal analysis. For the same period, the database also gives the amount of perceived indemnities from ex-post payments.

Although neglected in crop insurance literature, the farmers' financial wealth has to be considered as an essential parameter in the decision to insure (Harrington and Niehaus, 1999). The idea is that the largest businesses are more willing to cover their potential losses because their stakes are higher.

In the analysis, we take into account standard individual indicators for the farm manager such as its age, gender and education level. We can also consider whether a single farmer or a group of farmers exploits the farm. One can think that insured farmers are more educated and have a greater experience than non-insured one. Otherwise, young farmers may be more sensitive to new risk management products as they can receive more subsidies for their insurance policies.

Among the agricultural area indicators, we consider the total, cultivated and irrigated surfaces. We also take into account the farm's cultures portfolio and its technical economic-activity specialization (vegetables, cattle, or both). In fact, the diversification of the activities is a way to stabilize the annual turnover of the farm[40]. Then, it can be assimilated to a substitute to specific insurance products. Irrigation is also perceived as a mean to hedge crop risk because it reduces soil moisture and desiccation, and increases yield return. On the

[40] We considered as specialized farmers those which farms revenue could be attributed up to 65% from one crop.

contrary, biological agriculture seems to be a more risky activity.

The FADN database offers direct ways to determine the location and altitude of the farm and if it is located in a less favored area. Then, we can associate to each place different weather indicators that are considered as relevant by literature. We use the annual mean temperature and the annual cumulated precipitations. Starting from these original variables, we convert them by taking the square deviation from their average for each year. Then, we can capture the farmers' sensitivity to excessive variations of the climate. We can assume that farmers are risk-averse against excessive variations and that the most exposed will subscribe crop policies. On the contrary, adverse selection effects may put them out-of-the-market as a consequence of catastrophic results for the insurance company. One can also consider that after a major event like drought or excessive rainfall, the farmers will be more willing to insure their crops. In contrast, the lack of catastrophic events may not be an incentive.

Empirical Strategy

Adaptation to climate change through adoption of insurance can be framed within the standard theory of technology adoption. In this setting one can model a representative risk averse farm household as choosing to adopt an insurance scheme to maximize her expected utility from final wealth at the end of the production period, given the production function and her land, labor and other resource constraints. Assuming that the utility function is state independent, solving this problem would give an optimal mix of adaptation measures undertaken by the representative farm household which is given by equation 1.

$$A_{hi} = A(x_{hi}^{h}, x_{hi}^{l}, x_{hi}^{c}; \beta) + \varepsilon_{hi} \quad (1)$$

where *A* represents the is *h-th* insurance undertaken by the household h, and $x_{ht}^{h}, x_{ht}^{l}, x_{ht}^{c}$ are household characteristics, land and other farm characteristics, and climatic variables respectively. β, is the a vector of parameters, and ε_{hi} is household specific random error term. Households choose adaptation strategy 1 over adaptation strategy 2 if and only if expected utility from adaptation strategy 1 is greater than adaptation strategy 2, i.e. $E[U(A_1)] > E[U(A_2)]$.

A dummy variable is employed to measure if the farm households have adopted any insurance in response to changes in climate. A probit regression is adopted to estimate determinants of adoption of insurance as specified by equation 1. The central focus of this study is to investigate if climate change and adaptation have any impact on the value of production. Adaptation is measured by a dummy variable is entered into a standard household production function, y_{ht}, as specified in equation 2.

$$y_{hi} = f(x_{hi}^{s}, x_{hi}^{c}, A_{hi}, \gamma) + \xi_{hi} \quad (2)$$

where x_{ht}^{s}, x_{ht}^{c}, r_{ht} are conventional inputs, climatic factors, and climate change adaptation measure, respectively, γ is a vector of parameters, and ξ_{ht} is household specific random error term. The role of A_{hi} is inserted via the predictions from the system of equations (1). To estimate the value of production model in equation (2), we employed a pseudo-fixed effect model. Use of a standard fixed effect model has an obvious advantage over random effect and other linear models (such as Tobit or truncated regressions). It produces consistent parameter estimates by controlling unobserved heterogeneity that might be correlated with observed explanatory variables. However, standard fixed effect models rely on data transformation that removes the individual effect. It can be important, instead to model the individual effect. This is particularly true in our case that the variable of interest (adaptation) is measured at household level. One way to address this issue is to run a random effect model but at the same time control for unobserved heterogeneity using Mundlak'a approach (Wooldridge 2002). This approach is some times referred in the literature as Pseudo-fixed effect model. The right hand-side of our pseudo-fixed effect regression equation includes the mean value of the time (plot)-varying explanatory variables following Mundlak's (1978) approach. This approach relies on the assumption that unobserved effects are linearly correlated with explanatory variables as specified by:

$$\psi_h = \bar{x}\alpha + \eta_h, \ \eta_h \sim \mathrm{iid}(0, \sigma_\eta^2) \quad (3)$$

where $\bar{x}$ is the mean of the time varying explanatory variables within each household (cluster mean), α is the corresponding vector coefficient, and η is a random error unrelated to $\bar{x}'s$. The vector α will be equal to zero if the observed explanatory variables are uncorrelated with the random effects. The use of fixed effects techniques and Mundlak's approach also helped address the problem of selection and endogeneity bias, if the selection and endogeneity bias are due to time invariant unobserved factors, such as household heterogeneity (Wooldridge, 2002). If we failed to control for these factors, we would not obtain the true effect of adaptation. Thus, the use of the pseudo-fixed effect model in this paper helps to address the potential endogeneity bias due to the inclusion of the adaptation variable in the right hand side of the food production model. Moreover the estimation of the parameters α allows us to test for the relevance of the fixed effects via an F test. The test is implemented on the estimated coefficient in the vector α are jointly equal to zero. We rejected the null hypothesis. It is, therefore, important to adopt a fixed effects specification. To further probe our results we consider the situation in which the variable insurance is endogenous by fitting a treatment-effects model. Thus we consider the effect of an endogenously chosen binary treatment conditional on two sets of independent variables (Wooldridge, 2001).

[Table 1 – About here]

Results

Table 2 reports the econometric results. For robustness check we provide both the results from the four different specifications. We compare the situation in which we estimate the model controlling for the fixed effect and we extend it considering the potential endogeneity of the variable insurance. The top part of column (1) presents the fixed effect specification. The bottom part presents a separate probit equations. Both column (2) and (3) are presenting the treatment model (using MLE) where the variable insurance is considered as endogenous. Column (4) reports the estimation resulted obtained by a two steps approach. The last column provides the same specification as (3) where we include quadratic terms for the climatic variables.

The robustness of the endogenous treatment model relies on the existence of instruments (or excluding conditions). Otherwise the parameters identification will happen only via the non linearity of the treatment equation. While this is theoretically possible is not advisable (Wooldridge, 2001). As "instruments" we used lagged value of the weather variables: minimum and maximum high temperature. These are variables that can affect the propensity to insure but do not affect this year revenues. The estimated coefficients are very consistent. All the factors of productions are positively correlated with farm revenues. Thus land, seeds and fertilizers seem to play a very important role in determining revenues. The variable "chemical" displays many zero values. Basically almost 30 per cent of the sample are using no chemical fertilizers. This large presence of zeros may bias the estimation. To include this important variable in the log –log , we follow Battese (1997), using [β0D + β 1ln(Chemical + D)], where D = 1 if Chemical = 0, and D = 0 if Chemical t > 0, and β 0 and β1 are the parameters.

[Table 2 – About here]

The impact of climatic variable is very important. We extended the model to consider also the case of non linearities (Seo and Mendelsohn, 2008). We find that all the quadratic terms are statistically significant. We calculated the marginal effects and found that (evaluated at sample means) the maximum temperature impact is equal to -0.14. The effect of the minimum temperature is equal to 0.49. It should be noted however, that the inclusions of the quadratic terms does not changes the qualitative results. For instance, with the inclusion of the quadratic term the effect of rain is still positive (0.0003). Same thing applies to the extreme temperature. For the whole sample the effect of This implies that there is no evidence of a turning point with the data at hand. This is not surprisingly given that irrigation is available. We have a consistent result on the variable insurance. It is always positively correlated with revenues irrespective of the specification. Therefore, the adoption of an insurance scheme increase farmers' welfare. It is interesting to note that crop diversification ha a positive impact on farmers' welfare as well. This is consistent with existing findings in the literature that highlight higher productivity and revenues of more diversified farms. Looking at the treatment equation we can identify some of the key variables that drive the decision to adopt insurance. Interestingly farmers that have larger land endowments are less likely to adopt an insurance scheme. This may highlight the fact that farmers with larger land endowments can hedge better against extreme events. The use of seeds and chemicals is actually positively correlated. It is interesting to note that farms that have more crop diversification are more likely to adopt the insurance scheme. This may indicate that crop diversification may act as complete for financial insurance and not as substitute (Baumgartner, 2007). The effect of climatic variables on the take up of insurance is as expected. We explored with different quadratic terms. We drop the quadratic term for rain. The quadratic terms the extreme temperatures are statistically significant. This may indicate the existence of threshold levels.

Conclusions

Improving farmers's ability to withstand extreme weather events, particularly those predicted as a result of climate change, is of paramount importance in modern agriculture. Farmers may manage the more challenging weather conditions via both conventional strategies (i.e. changing cropping patterns) and financial insurance. To understand the viability of the insurance schemes we need to understand *1)* the underlying factors that determine farmers decision to adopt an insurance scheme against extreme events., and *2)* the implications in terms of welfare. In this paper we aimed to tackle these two questions by providing empirical evidence of the determinants of the decision to insure against extreme events and its implications on farmers' welfare. We have used a very rich farm level panel data from Italy. We have access to information regarding more than 8000 farms followed for 4 years. We considered in our analysis possible effects of weather variables on yields, we specified an equation where farm revenues are regressed against weather variables. We estimated a set of different models. We inserted fixed effect and controlled for the potential endogeneity of the the decision to adopt insurance to extreme events. We have found that the insurance is positively correlated with welfare (captured by farm revenues). In this context, since insurance seems to be a very important tool for risk management, would be important at the farm level to implement policies that increase the diffusion and the access to insurance markets.

The analysis of the determinants of the decision to insure unearthed some interesting information. Farmers that have larger land endowments are less likely to adopt an insurance scheme, while farms that have more crop diversification are more likely to adopt the insurance scheme. This may indicate that crop diversification may act as complement for financial insurance and not as substitute. The effect of climatic variables on the take up of insurance is as expected. There is evidence of a statistically significant quadratic terms for the extreme temperatures. This may stress the importance of reaching some threshold level in order to adopt the insurance scheme.

References

1. Baumgärtner, S. (2007). The insurance value of biodiversity in the provision of ecosystem services. Natural Resource Modeling 20(1), 87-127
2. Blank S.C. and McDonald J. (1996). Preferences for Crop Insurance When Farmers Are Diversified. Agribusiness 12(6): 583-592.
3. Battese, G.E. 1997. "A Note on the Estimation of Cobb–Douglas Production Functions
4. When Some Explanatory Variables Have Zero Values." Journal of Agricultural Economics
5. 48:250–52
6. Cafiero C., Capitanio F., Cioffi A., Coppola A. (2007) Risk and Crises Management in the reformed European Agricultural Crises Policy, Canadian Journal of Agricultural Economics 55, 419-441.
7. Choi B.P. and Weiss M.A. (2005). An Empirical Investigation of Market Structure, Efficiency, and Pperformance in Property-Liability Insurance. Journal of Risk and Insurance 72 (4): 635-673.
8. Froot, K. A., 2001, The Market for Catastrophe Risk: A Clinical Examination, Journal of Financial Economics, 60: 529-571.
9. Garrido A. and Zilberman D. (2007). Revisiting the Demand of Agricultural Insurance: The Case of Spain. Contributed paper presented at the 101st Seminar of the European Association of Agricultural Economists. Berlin, Germany.
10. Glauber J.W. (2004). Crop Insurance Reconsidered. *American Journal of Agricultural Economics* 86 (5): 1179-1195.
11. Goodwin B.K. (1993). An Empirical Analysis of the Demand for Multiple Peril Crop Insurance. American Journal of Agricultural Economics 75: 425-34.
12. Grace M.F., Klein R.W. and Kleindorfer P.R. (2004). Homeowners Insurance With Bundled Catastrophe Coverage. Journal of Risk and Insurance 71 (3): 351-379.
13. Harrington S.E. and Niehaus G.R. (eds) (1999). Risk Management and Insurance, Irwin/McGraw-Hill, 674p.
14. Kelly M. and Kleffner A.E. (2003). Optimal Loss Mitigation and Contract Design. Journal of Risk and Insurance 70 (1): 53-72.
15. Knight, T.O. and Coble, K.H. (1997), ''Survey of US multiple crop insurance literature since 1980'', Review of Agricultural Economics, Vol. 19, pp. 128-56.
16. Lustig H.N. and Van Nieuwerburgh S.G. (2005). Housing Collateral, Consumption Insurance and Risk Premia: An Empirical Perspective. Journal of Finance LX (3): 1167-1219.
17. Mishra A.K. and Goodwin B.K. (2003). Adoption of Crop versus Revenue Insurance: A Farm-Level Analysis. Agricultural Finance Review Fall 2003, 143-155.
18. Niehaus G. (2002). The Allocation of Catastrophe Risk. Journal of Banking and Finance 26: 585-596.
19. Puelz R. (1999). Reviewed work: Risk Management and Insurance. Journal of Finance 54 (3): 1187-1189.
20. Schär C., Vidale P.L., Lüthi D., Frei C., Häberli C., Liniger M.A. and Appenzeller C. (2004), " The role of increasing temperature variability in European summer heatwaves", Nature, 427, 332-336.
21. Serra T., Goodwin B.G. and Featherstone A.M. (2003). Modeling Changes in the U.S. Demand for Crop Insurance During the 1990s. Agricultural Finance Review Fall 2003, 109-125.
22. Swiss Re (2004), "Climate change futures: Executive roundtable" (Swiss Re, Centre for Global Dialogue, Ruchlekon, Switzerland, 2004).
23. Van Asseldonk, M., Meuwissen M. and Huirne R. (2002). Belief in Disaster Relief and the Demand for a Public-Private Insurance Program. Review of Agricultural Economics 24(1): 196-207.
24. Wang H.H. and Zang H. (2003). On the Possibility of a Private Crop Insurance Market: A Spatial Statistics Approach. Journal of Risk and Insurance 70 (1): 111-124.
25. Wright, B. D. and Hewitt J. A. (1994), "All-Risk Crop Insurance: Lessons From Theory and Experience. In D. L. Hueth e W. H. Furtan (A cura di,), Economics of Agricultural Crop Insurance: Theory and Evidence, Chapter 4, pp. 73-112. Boston/Dordrecht/London: Kluwer Academic Publishers.
26. Zanjani, G. (2002). Pricing and Capital Allocation in Catastrophe Insurance, Journal of Financial Economics, 65, 283–305.

Table 1. Variables Descriptive Statistics

Variables	Mean			St.dev.		
	North	Middle	South	North	Middle	South
Chemical Fertilizers (Euro) in logs	3403,92	2316,49	1979,22	11333,77	6701,16	10423,08
Seeds (Euro) in logs	5364,76	4787,02	3786,52	42299,93	38880,40	25998,88
Land (hectares) in logs	35,25	37,95	32,34	95,69	73,08	56,73
Minimum Temperature (°C)	5,12	9,58	12,14	31,34	42,45	31,85
Maximum Temperature (°C)	17,54	19,35	21,40	63,54	73,15	62,13
Rain (mm/year)	784,32	721,89	705,23	234,56	341,68	367,15
Fertility (higher fertility degree)	*	*	*	*	*	*
Div (crop diversification degree)	*	*	*	*	*	*
Insurance (crop insurance premium paid Euro)	297,81	107,08	81,73	4400,17	1079,87	1214,37
ass_prod (producers organization)	*	*	*	*	*	*

Table 2. Estimation results

Variables	Fixed Effects (1)	Fixed Effects Insurance endogenous MLE (2)	Fixed Effects Insurance endogenous MLE (3)	Fixed Effects Insurance endogenous Two steps (4)	Fixed Effects Insurance endogenous MLE (5)	Fixed Effects Insurance endogenous MLE (6)
Dependent Variable: Farm Revenues						
Insurance	**0.194*****	**1.370*****	**1.351*****	**2.493*****	**1.329*****	**1.341*****
	(0.0293)	(0.0388)	(0.0389)	(0.120)	(0.0392)	(0.0391)
Chemical	0.203***	0.169***	0.174***	0.132***	0.169***	0.169***
	(0.00722)	(0.00823)	(0.00821)	(0.00981)	(0.00819)	(0.00819)
Dummy for chemical	1.548***	1.365***	1.371***	1.127***	1.346***	1.343***
	(0.0458)	(0.0522)	(0.0519)	(0.0612)	(0.0518)	(0.0519)
Land	0.480***	0.474***	0.465***	0.464***	0.469***	0.469***
	(0.00945)	(0.00862)	(0.00863)	(0.00935)	(0.00861)	(0.00862)
Seeds	0.0144***	0.0122***	0.0111***	0.00682*	0.0117***	0.0117***
	(0.00350)	(0.00379)	(0.00377)	(0.00411)	(0.00376)	(0.00376)
Min Temperature	0.0363***	0.0498***	0.0482***	0.0482***	0.287***	0.260***
	(0.00511)	(0.00629)	(0.00626)	(0.00679)	(0.0319)	(0.0332)
Min Temperature^2					-0.0164***	-0.0148***
					(0.00203)	(0.00212)
Max Temperature	-0.0855***	-0.0994***	-0.101***	-0.104***	-0.882***	-0.870***
	(0.00533)	(0.00648)	(0.00646)	(0.00701)	(0.0841)	(0.0878)
Max Temperature^2					0.0235***	0.0233***
					(0.00254)	(0.00265)
Rain	0.000406***	0.000207***	0.000181***	0.000278***	-0.005***	-0.00317***
	(0.0000525)	(0.0000686)	(0.0000684)	(0.0000747)	(0.00114)	(0.00121)
Rain^2					0.0000036***	0.00000215***
					(0.000000746)	(0.000000786)
Fertility	0.276***	0.243***	0.242***	0.200***	0.244***	0.243***
	(0.0180)	(0.0196)	(0.0195)	(0.0216)	(0.0195)	(0.0195)
Diversification	0.257***	0.231***	0.241***	0.208***	0.233***	0.234***
	(0.0136)	(0.0200)	(0.0200)	(0.0219)	(0.0199)	(0.0199)
Producers Association			-0.162***	-0.154***		-0.176***
			(0.0150)	(0.0163)		(0.0151)
Constant	7.979***	8.549***	8.835***	9.172***		15.69***
	(0.0907)	(0.109)	(0.111)	(0.125)		(0.795)
Dependent Variable: Insurance						
Chemical	0.437***	0.383***	0.389***	0.439***	0.388***	0.388***
	(0.0277)	(0.0290)	(0.0290)	(0.0278)	(0.0291)	(0.0291)
Dummy for chemical	2.102***	1.750***	1.798***	2.106***	1.809***	1.807***
	(0.247)	(0.269)	(0.269)	(0.247)	(0.267)	(0.266)
Land	-0.0394*	-0.216***	-0.219***	-0.0455**	-0.219***	-0.222***
	(0.0221)	(0.0211)	(0.0211)	(0.0222)	(0.0212)	(0.0212)
Seeds	0.101***	0.308***	0.303***	0.100***	0.304***	0.304***
	(0.0162)	(0.0202)	(0.0202)	(0.0162)	(0.0202)	(0.0202)
Min Temperature	0.0219	-0.0870**	-0.0864**	0.0195	0.0611	0.305***
	(0.0480)	(0.0394)	(0.0395)	(0.0481)	(0.0405)	(0.0873)
Max Temperature	-0.1000***	-0.0344	-0.0427	-0.103***	-0.0198	-0.0129**
	(0.0321)	(0.0278)	(0.0279)	(0.0321)	(0.0282)	(0.00574)
Rain	-0.00159***	-0.00183***	-0.00185***	-0.00163***	-0.00155***	-0.379*
	(0.000273)	(0.000234)	(0.000235)	(0.000273)	(0.000238)	(0.223)
Fertility	0.352***	0.249***	0.248***	0.349***	0.256***	0.0102
	(0.0508)	(0.0449)	(0.0450)	(0.0508)	(0.0449)	(0.00699)
Diversification	0.314***	-0.0839	-0.0656	0.324***	-0.0667	-0.0188***
	(0.0611)	(0.0546)	(0.0551)	(0.0613)	(0.0549)	(0.00266)

Table 2 (continued)

Lag.Min Temperature	-0.0577	0.0534	0.0588	-0.0533	0.0384	-0.129***
	(0.0490)	(0.0399)	(0.0401)	(0.0491)	(0.0410)	(0.0406)
Lag Max Temperature	0.192***	0.130***	0.132***	0.193***	0.0993***	0.0909***
	(0.0336)	(0.0285)	(0.0285)	(0.0336)	(0.0291)	(0.0342)
Producers Association			-0.0526	-0.103**	-0.0549	-0.0819
			(0.0373)	(0.0420)	(0.0373)	(0.0547)
Constant	-6.596***	-6.509***	-6.369***	-6.381***	-6.473***	-5.096***
	(0.366)	(0.319)	(0.328)	(0.376)	(0.333)	(1.724)
N	25560	17032	17032	17032		

Adj. 2 :0.486 - Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Hansen J statistic (overidentification test of all instruments): 1.13, Chi-sq(1) P-val = 0.28.
Test of excluded instruments: F(2, 17017) = 17.98 Prob > F = 0.0