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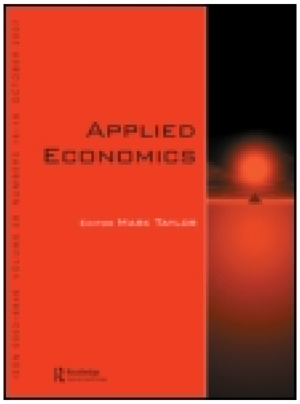

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Does market competitiveness significantly affect public intervention in agricultural insurance: the case in Italy

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Does market competitiveness significantly affect public intervention in agricultural insurance: the case in Italy†

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Analyses of agricultural insurance failures often assume the existence of competitive supply, tracing the reasons for high insurance cost and limited farmer participation to informational problems, and suggesting the need for premium subsidization in order to increase participation. However, in countries such as Spain and Italy, where agricultural insurance is most highly subsidized, it could be that supply is not fully competitive. In this article, we explore the incidence of public subsidies to agricultural insurance premia when supply is noncompetitive. Through the use of a simple empirical model of an insurance market, it is shown that, while in the case of a competitive supply, subsidies to insurance would benefit farmers, a monopolistic supply would capture most of the subsidy, thus eliminating the potential incentive towards wider participation by farmers. The model is applied to a panel of Italian farms for different levels of risk aversion to demonstrate the limited effect that a subsidy to a hypothetical all risk yield insurance would have on farmer participation in the case of monopolistic supply.

I. Introduction

The world is undergoing a transition reflecting the new demographic, climatic, ecological and economic reality. The topic of resource scarcity measured against growth dynamic imposes the constraint of sustainability across the board, but first and foremost on more developed areas: water, energy and food are beginning to become scarce resources or at risk of scarcity. Scarcity is further challenged by another

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† This article is based on the research originally published as Capitanio and Cafiero (2006), and must be considered the product of joint effort by the authors. However, Fabian Capitanio is the main author of Sections II and III, while Maria Bielza has taken the lead in drafting Section IV.

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consequence of the great pressure upon productive resources in the recent years, the phenomenon of climate change. Contemporaneously, in Europe, the Common Agricultural Policy (CAP) reform process had already gathered speed by the 2003 reform, which outlined a new approach to European intervention in the farm sector and in rural areas, privileging agriculture's contribution to constructing positive social values and progressively reducing the weight of market protection and internal price support (Buckwell, 2007). In this context, one of the new challenges addressed by the Health Check in 2008 explicitly foresees the issue of the risk management as a fundamental matter of the future public intervention.

The management of risk in agriculture and the role of insurance have long been the centre of attention for researchers and policymakers. A review of the literature on the subject consistently shows the failure of private markets for comprehensive (multiperil) agricultural insurances and their unsustainability in the absence of any public intervention. Even with strong public support, insurance demand is not often as high as could be expected. Reasons for such failures are usually found in either supply or demand conditions. On the supply side, the most explored issues are asymmetric and incomplete information (Chambers, 1989; Miranda, 1991; Skees *et al.*, 1997; Just *et al.*, 1999; Mahul, 1999; Bourgeon and Chambers, 2003), with the resulting problems of adverse selection, moral hazard and systemic risk, which may pose the most serious obstacle to the emergence of an independent private comprehensive crop insurance industry. Especially, due to the systemic character of yield risks, reinsurance becomes very expensive. Without government subsidies or public reinsurance, insurers pass this high cost to the farmers' premiums (Doherty and Dionne, 1993; Miranda and Glauber, 1997; Mahul, 2001). On the demand side, the inability of farmers to assess precisely the benefits derived from agricultural insurances is often cited as one possible reason for limited demand. Another explanation for the limited interest in Multi-Peril Crop Insurance (MPCI) is simply that the organizational structure of farming is such that farmers can use other private instruments – such as product diversification, credit, financial markets and so on – to manage risk and therefore that the potential demand for crop insurance is lower than commonly believed (Wright and Hewitt, 1994).

Although the arguments have some merit, these reasons are not convincing, and are definitely not exhaustive of the list of possible causes of the observed conditions of insurance markets in agriculture throughout the world. One aspect that has been neglected by most of the current literature on agricultural insurance is the competitive structure of the insurance market. The argument deserves attention: after all, a market equilibrium where high prices and limited participation prevail could simply be the result of monopolistic pricing behaviour. From a social welfare point of view, this issue deserves a special consideration whenever public intervention is involved, as happens in most cases of agricultural insurance in developed countries.

In Europe, insurance plays a central role in the Spanish and Italian systems (Joint Research Centre (JRC) report by Bielza *et al.* (2006) and Cafiero *et al.* (2007)) with a large government involvement providing subsidies for a wide range of insurance coverage, as well as public reinsurance for insurance losses. Besides, the Spanish system of risk and crisis management does not provide disaster compensations when insurance against the event is offered. For noninsurable events, ad hoc disaster payments are available to farmers, but most often only if the producer had already purchased agricultural insurance for covered perils. In Italy, both *ex post* compensation for damages due to exceptional events and subsidies to crop insurance have been available to farmers since 1974. *Ex post* assistance has consistently received the largest share of budget appropriations: on average, over the last 20 years, 72% of public expenditure has been directed to *ex post* compensation, while insurance subsidies have absorbed the remaining 28%. The generous access granted to compensations for damages due to exceptional events is likely to be among the reasons for the limited diffusion of insurance in Italian agriculture. Despite the presence of subsidies to the premiums of about 40% on average, the share of insured value on total crop production has never exceeded 15% (on average 12% in value and 8% in surface on total production for the period 2001–2005). To try to handle the problem of the limited development of the insurance market, recent changes in the legislation have introduced the possibility of publicly provided reinsurance and increased the subsidy to the premiums for new forms of insurance coverage. Outside Europe, many governments are heavily involved in subsidizing crop insurance premium. In this context, the public role experienced in the USA and Canada is apparent, where the US system is based on a system of widespread, highly subsidized, MPCI[1], and in

[1] Unlike Italy, where a large number of companies share the market, but premiums are fixed by the government and the government covers the companies' administrative costs and provides reinsurance.

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Canada, while private insurance is almost nonexistent, the government provides farmers with MPCI though a Production Insurance (PI) Programme. In the US despite a continued increase in the levels of subsidies to the premiums and the introduction of new forms of highly subsidized revenue insurance, the objective of reducing ad hoc appropriations for agricultural damage compensation has never been achieved (Chambers, 2007).

Since many governments throughout the world have paid or still pay high subsidies to sustain agricultural insurance, it is thus legitimate to ask who might benefit the most from such a type of intervention. The effects of a subsidy on the premiums and the distribution of the benefits can differ considerably under different competitive structures of the market. If suppliers can exert market power, it is easily conceivable that a part of the subsidy would be captured as monopoly rents, thus limiting the incentives on farmer participation. How much of the subsidy is going to be captured as rents and what the effects on actual farmer participation are, remain empirical questions that need to be answered on a case-by-case basis. Starting from this consideration, this article aims at studying the effects of a hypothetical policy intended to sustain agricultural insurances through a subsidy on premiums, under the hypothesis of two extreme forms of supply: perfect competition and monopoly. This question is really striking for the Italian case where private companies set the premium, and it might be relevant in Spain and the USA in terms of the power market in delivering policies: Babcock (2009) pointed out that in the USA, the total premium has increased dramatically since 2001 especially due to the high costs of delivery, which could represent a signal of market power of the insurance companies.

This article is structured as follows. A simple model of the market for an all-risk insurance contract is presented in Section II. Section III presents the data and methodology and Section IV presents the results of an empirical analysis aimed at simulating the predictable performances of such a contract on a sample of Italian farms. Section V shows the main conclusions of the analyses.

II. A Simple Model of an all Risk Yield Insurance

We assumed a set of N farms specialized in the production of one product and indicate with $y_{i,t}$ the unit (per hectare) detrended actual crop yield of the ith farm in period t.

We assume that the farmer has the option of buying financial insurance under the following contracts: (i) the farmer chooses the fraction $a \in [0, 1]$ (a) of insurance coverage; (ii) he receives (pays) $a(\varepsilon s - s)$ from (to) the insurance company as an actuarially fair indemnification benefit (insurance premium) if his realized income is below (above) the mean income. In order to abstract from any problems related to informational asymmetry, we assume that the statistical distribution are observable to both the insurant and the insurance company; (iii) in addition to (a), the farmer pays the transaction costs of insurance. The costs of insurance over and above the actuarially fair insurance premium, which are a measure of the real costs of insurance to the farmer, are assumed to follow the cost function Δa var s (b) where the parameter $\Delta a \geq 0$ describes how actuarially unfair is the insurance contract.

The costs increase linearly with the insured part of the income variance. This captures in the simplest way the idea that the costs of insurance increase with the extent of insurance.

The farm's yield varies for reasons beyond the farmer's control, so that there exists a potential demand for insurance.

A simple insurance contract can be defined by the pair (π, ψ), where π is the premium and ψ the guaranteed yield. Each farmer has a Willingness To Pay (WTP) for insurance, denoted by $\text{WTP}_i(\psi)$, which depends on his/her risk preferences, on the distribution of his income and on the insurance characteristics (guaranteed yield). The WTP calculation methodology is shown in the following section.

The total demand for this type of insurance will be equal to the sum of the individual demands by farmers whose WTP is equal to or exceeds π Given the distribution of farms in terms of individual yield productivity and a level of guaranteed yield, we can derive the market demand function by summing up, for each value of the premium, the total area of farms whose WTP is higher or equal to the required premium

$$D_i(\pi, \psi) = \sum_{i=1}^{N} \gamma_i h_i \tag{1}$$

where h_i is the area of the ith firm and γ_i an index:

$$\gamma_i = \begin{cases} 1 & \text{if } \text{WTP}_i(\psi) \geq \pi \\ 0 & \text{otherwise} \end{cases}$$

For any conceivable yield distribution, the demand will be such that $\partial D(\pi, \psi)/\partial \pi < 0$ and $\partial D(\pi, \psi)/\partial \psi > 0$.

For a given sample of firms, an insurance contract will determine revenues (given by the premiums paid

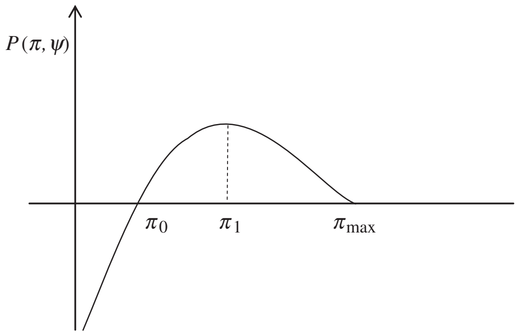

Fig. 1. Insurance industry's profits

by farmers) and costs (indemnity payments) for the insurance industry. The expected net profits of the insurance industry will be

$$P(\pi,\psi)=\sum_{i=1}^{N}\left\{\gamma_i E\big(h_{it}\big[\pi-\max\{\psi-y_{it},0\}\big]\big)-\gamma_i h_i C\right\} \tag{2}$$

We call C the total (fixed and unitary) administrative costs of the insurance company, expressed as unitary costs per insured hectare. We will consider C a fixed amount for practical reasons. The actual form of this relation (Equation 5) depends on the distribution of yields and on the WTP function. We predict that, when plotted against π, the profits function will assume an inverted U-shape. Initial values of profits are certainly negative, corresponding to zero values for the revenues (for $\pi=0$, all farmers would sign the contract, with no revenues for the insurance company and the highest possible amount of indemnities to be paid). As the value of the premium increases, some farms will refrain from signing the contract, and therefore the value of indemnities to be paid will fall, whereas the value of revenues for the insurance industry will grow, thanks to the payments by those who remain in the contract. Net profits for the insurance industry will reach a maximum at the premium π_1 as shown in Fig. 1. At higher levels of premium, the firms that remain in the market will be those with higher risk, with the consequence that the total amount of indemnities to pay will decrease more slowly than the amount of premiums collected. A market will be sustainable if the maximum of the curve in Fig. 1 corresponds to nonnegative profits. Intuitively, we can define two possible equilibriums depending on the competitive structure of the supply of insurance, shown in Fig. 1.

With no barriers to entry, and apart from any market failure due to asymmetric information, the equilibrium premium will be the lowest value compatible with the positive profits (close to π_0) given that new firms will offer contracts with the same guarantee level at a lower premium whenever there are profit opportunities. In a monopolistic market, with no competitive threat by potential entrants, the equilibrium premium will be the one that maximizes profits (π_1).

Formally, we suppose that profit for monopolist would be: $\pi=qD(q)-C(q)$ and $\frac{d\pi}{dq}=D(q)+qD'(q)-C'(q)$, so that, if we impose $d\pi/dQ=0$ by obtain the profit maximization, we get $D(q)+qD'(q)=C'(q)$. More simply, MR = MC, which represents the first order condition.

In case of perfect competition market, if $C(Q)$ represents the total costs and Q the quantity, profits are: $\pi=PQ-C(Q)$; in this context, the equilibrium market would be equal at $P-\frac{dC(Q)}{d(Q)}=0$, i.e. $MC=P$.

The introduction of a subsidy

The above-mentioned simple model can be used to simulate the effects of the introduction of a subsidy paid by the government, so that the effective premium paid by farmers will be $\tilde{\pi}=(1-s)\pi$ where s is the subsidy level expressed as a percentage of the market premium. Accordingly, the demand from Equation 1 is modified, so that the index γ_i becomes

$$\gamma_i=\begin{cases}1 & \text{if } \mathrm{WTP}_i(\psi)>\tilde{\pi}\equiv(1-s)\pi\\ 0 & \text{otherwise}\end{cases} \tag{3}$$

How this will change the profit function for the insurance industry is not clear: the higher participation will increase both revenues and costs; the premiums received by the insurer are the former (revenues), while the latter (costs) are identified with the amount of indemnities paid and the administrative cost. The ultimate change in the insurance industry's profit function will depend on the distribution of yields across farms and on the utility distribution function.

III. Data and Methodology Description

The data

In order to analyse the effects of the introduction of a subsidy on the premium of all risk insurance on yields, we have utilized a panel of farms taken from the Italian Farm Accountancy Data Network–Reading Instruction Competence Assessment (FADN–RICA) dataset for the Emilia Romagna region; from the RICA database, we have selected 242 farms over the period 1980 to 2005.

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We focus on wheat-producing farms of the mountainous area[2] in that region. The choice of the crop and the area is justified by the need to have a dense enough panel of farms which have been recorded for a sufficient number of years to allow for a characterization of the individual farm-yield variation.

Crop yields have realized substantial changes in recent years as improved production techniques have been adopted. Conceptually, this means that the data-generating process underlying yield realizations is not stable but rather changes over time. Thus, one cannot combine the yields observed over different periods of time. To address the problem of structural changes in yields observed over time, a variety of methods for 'detrending' yield data have been adopted in the literature. According to (Zanini *et al.*, 2000, p. 4), some authors have taken advantage of sophisticated time series tools to model yield trends, including the unit root modelling approach (Wang *et al.*, 1998) and Auto-Regressive Integrated Moving Average (ARIMA) models (Goodwin and Ker, 1998). However, time series methods such as unit root tests and ARIMA models require large samples covering several decades. Granger and Newbold (1986) suggested that, as a rule of thumb, the number of sample observations that are necessary to fit an ARIMA should contain at least 40–50 observations. Davidson and McKinnon (1993) pointed out that the finite-sample statistics for unit roots depend on assumptions about the error term which are not commonly verifiable. In this context, our sample precludes the use of unit roots or the ARIMA process to identify the trend process. In this case, a more general approach concerning the adoption of least-squares regression techniques can be considered to account for deterministic trends that have moved yields up over time.[3]

The farm-specific yields observed in the states of nature were detrended by a linear function

$$y_{it} = \alpha_i + \beta_i t + \varepsilon_{it}, \quad \varepsilon \sim N(o, \sigma^2)$$

where y_{it} – is the yield of farm i in year t ($t = 1, \ldots, T$), α_i the regression constant for farm i, β_i the systematic change for farm i (it is assumed that the trend caused by technological change among other things will continue in the future) and ε a normal distributed random error term (Murdoch, 1966, p. 34).

In our case, the variance of the yields net of technology trend was examined using an F-test to detect any increase between periods. The data series exhibited no evidence of heteroscedasticty, which allows us to simply use Ordinary Least Squares (OLS) regression (a), accounted a deterministic trend.

The mean value of the detrended yields equals 6.45 T/ha.

The calculation of the farmers' WTP and the costs of insurance

The WTP of a farmer i for the insurance product can be calculated through different methods (Chambers, 2007 for a recent review of methods for valuing agricultural insurance). The method proposed by Chambers requires data on input prices, output prices and financial returns. Given our availability of data and looking for simplicity of calculations, we will use two different methods for calculating the farmers' WTP.

First, according to the present value model (Myers *et al.*, 2005), we price the value of the contract at the present value of the expected indemnity on the contract. Abstracting from price and interest rate,[4] and given a temporal horizon T, the present value of the monetary gross returns from insuring 1 hectare of crop with a contract that guarantees a minimum yield ψ to the ith farm is given by[5]

$$\text{Value}_i(\psi) = (1 + \xi)E\big(\max\{\psi - y_i, 0\}\big) \tag{4}$$

where $(1 + \xi)$ corresponds to the stochastic discount factor. This loading factor allows an additional return to insurers that compensated them for taking on any nondiversifiable risk incurred by holding the

[2] The Emilia Romagna region has a surface area of 22 123 km^2 which can be divided into a plain area (48% of the surface), a hilly area (27%) and the so-called 'mountainous area' (25%). This mountainous area has two highest points of 1047 and 746 m. Cereals occupy almost 9% of the agricultural surface and 4.3% of the total surface in the mountainous area (http://www.ermesagricoltura.it/documenti/statistiche/ra020962.pdf).

[3] Deviations from this trend can then be added to the current yields to produce a series of yields that can be compared over time. An important related issue that must be addressed when detrending yields involves the second moment of the detrended yield data, in particular, the relations of the variance of the yields with the level of yields. Goodwin and Ker (1998) evaluated this issue using parametric and nonparametric tests for heteroscedasticity, and their results indicated that the SD of yields tended to be proportional to the average yield. This suggests a somewhat different approach to normalizing yields.

[4] Price is unity, which will allow us to express all values in physical units, i.e. quintals per hectare (q/ha), and there is no time discount rate.

[5] In our study, either net benefits BT or premiums π are expressed in physical units per hectare.

insurance contract and/or for the transaction costs of selling contracts and processing claims. A risk-neutral farmer ($\xi = 0$) would be willing to pay a per hectare premium equal to the expected benefit

$$\mathrm{WTP}_i^{\circ}(\psi) = E\left(\max\left\{\psi - y_{i,}, 0\right\}\right) \tag{5}$$

As can be observed, this quantity is approximate to the value of the contract, but lower because the stochastic discount factor would be zero. We calculate this according to our discrete temporal dataset as

$$\mathrm{WTP}_i^{\mathrm{o}}(\psi) = \frac{1}{T}\sum_{t=1}^{T} \max\left\{\psi - y_{i,t}, 0\right\}$$

Results are shown in the Section 'Application without risk aversion and without costs'.

A risk averse farmer would be willing to pay a per hectare premium higher than the average expected benefit, the magnitude depending on his/her risk aversion[6]

$$\mathrm{WTP}_i(\psi) > E(\max\{\psi - y_{i,t}, 0\}) \tag{6}$$

Second, as the stochastic loading factor is not known, we used a different methodology in order to calculate the WTP for a risk averse farmer. The calculation of the WTP with risk aversion was made in the following way. If we assume that, without insurance, the farmer's or the firm's expected utility is given by

$$E[U(y)] = E[U(h_i y_{it} - c_i)] \tag{7}$$

where price is unitary, and c_i represents the farmer's production costs which we will assume are fixed. Then, with insurance, the utility would be given by

$$E[U_{\mathrm{ins}}(y, \psi)] = E[U(h_i y_{it} - c_i + \max(\psi - y_{it}, 0) - \mathrm{WTP}')] \tag{8}$$

In principle, the firm would be willing to pay for the insurance up to a maximum that equals his expected utility t that is without insurance. So, the WTP is the one that equals $E[U(y)] = E[U_{\mathrm{ins}}(y, \psi)]$.

For the calculation of the WTP, as it could be greatly distorted due to the less data available, we did not use historical data but a Monte Carlo simulation. The yields were generated following a beta distribution function[7] (1000 yield values were generated per farmer). The beta distribution is commonly used for crop insurance analyses (Goodwin and Ker, 2002 review several examples). The method described by Mitchell *et al.* (2004) could be used for the conditional beta density. If we know the mean, variance, maximum and minimum of farmers' yields, then the parameters ν and γ can be derived.[8] We assumed as mean and variance of the yield distributions those observed for each farmer; the maximum was taken from the maximum in the dataset (corresponding to a fairly homogeneous geographical area); the minimum was set equal to zero.

Individual farmers' profits were calculated from the generated yields multiplied by the average wheat surface minus the farms' costs. Due to the extremely low reliability of information on farmers' costs in the RICA dataset, we chose to simplify the calculations by assuming that they amount to 50% of the farmers' expected revenue $E[h_i y_{it}]$.

This methodology for the calculation of the WTP requires making assumptions on the utility function and on the risk aversion level. For the utility function, we considered a Decreasing Absolute Risk Aversion (DARA) and Constant Relative Risk Aversion (CRRA) of the type

$$U(x) = \frac{x^{1-r}}{1-r}$$

where r is the relative risk aversion coefficient. We made the simulations for several risk aversion levels: 0, 0.5, 0.8, 1.2, 1.5 and 2.0.

The shape of this utility function changes for the different risk aversion levels, showing some distorting values in most cases, mainly for negative values of the

[6] The average expected benefit was the threshold which we used. Our choice does not impede any other thresholds.

[7] The beta density function for yield y is

$$b(y) = \frac{(y-A)^{\nu-1}(B-y)^{\gamma-1}\Gamma(\nu+\gamma)}{(B-A)^{\nu+\gamma+1}\Gamma(\nu)\Gamma(\gamma)}$$

where A is the minimum, B the maximum, ν and γ are shape parameters (both >0) and $\Gamma(\bullet)$ the gamma function (Evans *et al.*, 2000).

[8] For a crop yield following a beta density, the mean and variance are given by $\mu_y = (B-A)\nu/(\nu+\gamma)$ and $\sigma_y^2 = (B-A)^2\nu\gamma/\left[(\nu+\gamma)^2(\nu+\gamma+1)\right]$, respectively. Solving these equations for ν and γ gives

$$\nu = \frac{(\mu_y - A)^2(B-\mu_y) - \sigma_y^2(\mu_y - A)}{\sigma_y^2(B-A)} \quad \text{and} \quad \gamma = \frac{(\mu_y - A)(B-\mu_y)^2 - \sigma_y^2(B-\mu_y)}{\sigma_y^2(B-A)}$$

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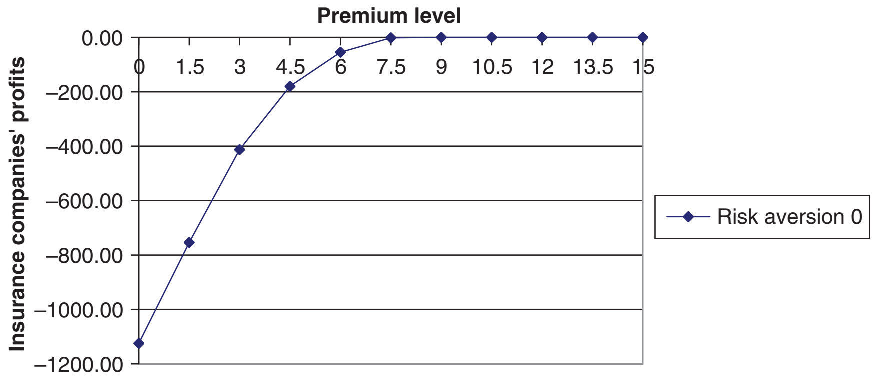

Fig. 2. Insurance companies' profits against premium level under risk neutrality and no insurance costs

argument x and for the $x=0$, where it shows a discontinuity, with nearby utility values growing to infinite or minus infinite. In order to avoid these distorting characteristics of the utility function, the values of the argument x (profits) have been cupped (minimum values have been set). Cupping of profits has been made at the value 0.01[9] quintals for $0<r<1$ (so, for $r=0.5$ and $r=0.8$), and at 1.01 quintals for $r>1$ (so, for $r=1.2$, $r=1.5$ and $r=2$).

The administrative costs of the insurance company should be an amount increasing with the number of insured farmers and with the insured surface, but the unitary costs per farmer should be decreasing with the number of farmers insured. However, we will assume that the unitary cost per farmer is a fixed amount. If, according to Bielza *et al*. (2006), the loss ratios in Europe are around 60–75%, this means that administrative and loss adjustment costs are more or less around 30–35% of the total premiums, and 40–50% of expected indemnities. So, we will assume that the administrative costs are 40% of the expected indemnities in the area.

$$C = 0.4E_{it}(\max\{\psi - y_{it}, 0\})$$

The subsidies

Until recently, subsidies in Europe varied from no subsidies to a maximum of around 75–80% of the premium in some cases (Portugal and Italy). However, there is a tendency to establish maximum insurance subsidies around 50% of the premium, in order to meet European Union (EU) guidelines (European Commission, 2006a) and new legislation (European Commission, 2006b). In the USA, premium subsidies on average amount to 58% of the total risk premiums, but the US government also provides funds for the administrative costs of the insurance companies and reinsurance. The total support thus provided to insurance would amount to 72% of the total premiums (Bielza *et al*., 2006).

We will perform our simulations for a lower level of subsidies, but high enough to make them significant in comparison with the current level of subsidies in many countries. So, the level of subsidy will be established at the 25% of the total premium.

IV. Empirical Application

Application without risk aversion and without costs

As mentioned in the previous section, calculations were made in a first step for the simplest case where we do not consider the companies' costs and we also assume that the farmers' WTP equals his expected indemnities. For this case, we obtained a graph shown in Fig. 2.

As can be observed in the graph, as the premium level increases profit increases. At a premium level close to 8 q/ha, profits become zero. However, as might be expected, the market is not sustainable because the maximum of the curve in Fig. 2 does not correspond to positive profits. The reason is that farmers are not risk averse, so they would be willing to pay up to a maximum of what they will perceive as indemnities, with no possibility of profit for the insurance companies. The existence of risk aversion is a need for the development of an insurance market.

Case with risk aversion and costs

Figure 3 shows the insurance industry's profit functions for the hypothetical market represented by the

[9] Average farm profits are between 18 and 843 quintals.

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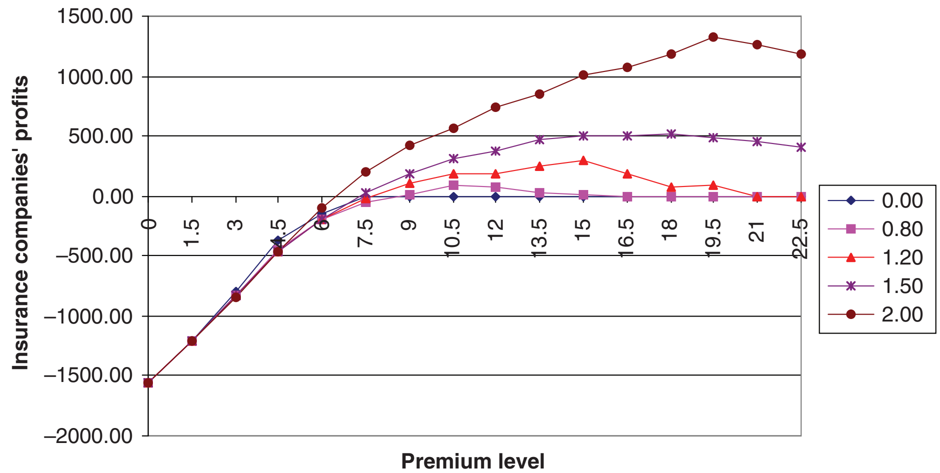

Fig. 3. Insurance companies' profits against premium level with insurance costs for different levels of risk aversion

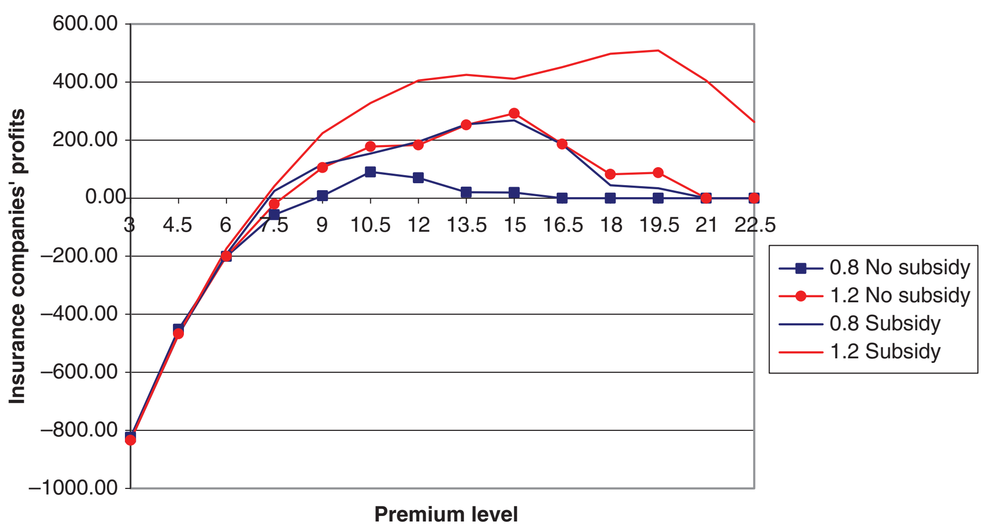

Fig. 4. Insurance companies' profits against premium level with and without subsidies

sample of RICA farms against premium levels, but taking into account administrative costs and for different levels of risk aversion. In this case, positive profits are possible. In the graph, risk neutrality has also been considered, but as can be observed, for a premium equal to zero, losses of the insurance company are around 1600 instead of 1100. This difference is due to the administrative costs of insurance, taking into account the fact that for this premium level all farmers would be insured. Instead, when the premium is around 8 q/ha, no farmers are insured, so no administrative costs modify the companies' economic results (all costs have been considered variable).

As can be seen in the graph, for lower levels of risk aversion, such as 0.8 and 1.2, we have the inverted U curve as mentioned in Section II. For very high levels of risk aversion, the premium levels at which the number of insured decrease are practically out of Fig. 3.

The effect of subsidies

Figure 4 shows the insurance industry's profit functions with and without a subsidy of 25% on the premium paid by the farmers. Results are shown for two levels of risk aversion, 0.8 and 1.2.

As can be observed, the results are similar and proportional for both the levels of risk aversion, in such a way that the subsidy increases the insurance companies' profits for any level of premium. In order to analyse these effects in further detail, we shall

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Table 1. The effect of a 25% subsidy on the premium for risk aversion 1.2

	Competition		Monopoly	
	Without subsidy	With subsidy	Without subsidy	With subsidy
Equilibrium premium (q/ha)	7.75	7.25	15	20
Participating farms (N)	52	82	19	19

focus only on one level of risk aversion (1.2), and only on two premium levels: the premium in a perfect competition environment (so, the premiums close to the point where profits are zero[10]) and the premium in a monopolistic situation (thus, the premium that maximizes total profits). These points are given in Table 1.

Table 1 first presents the equilibrium premiums in the case of competition and in the case of monopoly, and below the number of insured firms for each case. Without the subsidy, the equilibrium premium would be of 7.75 q/ha (or 12% of the mean yield of the sample) in a competitive market, and of 15 q/ha (i.e. 23% of the mean yield) under monopolistic supply. The number of firms that would sign a contract differ greatly in both extreme situations: while 52 firms (out of 142) would sign a contract at a premium of 7.75 q/ha, only 19 would do so for a more than double premium in the monopolistic case.

The introduction of a 25% subsidy to the premium would shift the industry's profit function as depicted in Fig. 4. Looking at the values given in Table 1, we can observe that the value of the market clearing premium in competitive conditions will diminish slightly, from 7.75 to 7.25 q/ha,[11] and the participation of farms will increase by 58%, from 52 to 82, mainly due to the lower effective premium paid by farmers. The effect will be very different assuming monopolistic behaviour of the supply: the premium that maximizes insurers' profit will increase from 15 to 20 q/ha (an increase of 33%) thus eliminating most of the incentive towards farmer participation that the subsidy is intended to achieve. Participation, in fact, would practically remain constant at 19 farms. In conclusion, we can see that the subsidy does not manage to increase farmer participation when the market is not competitive.

V. Discussion and Conclusions

The rhetoric that surrounds the debate on public support to privately delivered insurance in agriculture often claims that the benefit to a State because of the widespread use of insurance in agriculture lies in the sharing with private insurance companies a part of the financial burden imposed by the need to compensate farmers for damages due to natural causes. The evidence, however, seems to point against the merit of such argument, especially for the case of USA, where increasing subsidies to insurance premiums have never succeeded in the reduction of ad hoc compensatory payments (Glauber, 2004). In this article, we advance one possible complementary reason for why premium subsidization might not be effective in inducing wider participation by farmers and therefore in reducing the need for *ex post* compensation of damages, and such a reason might be the presence of monopolistic pricing by the insurance industry.

Our highly stylised model describes how a market for insurance might clear in the absence of informational problems and how the equilibrium might differ depending on the competitive structure of the supply of insurance contracts. It also allows us to predict the effect of the introduction of a subsidy under the ideal conditions of absence of informational problems.

By using a panel of farms from Italy, we first show that, if the market were competitive, a 25% subsidy on the premium might indeed induce wider participation by farmers. The reason is simple: competition would guarantee that the subsidy would be fully appropriated by farmers and the reduced cost would justify the use of multi-peril insurance. If competition is prevented, the profit-maximizing premium would be higher, and a market that is compatible with participation of farms with higher risk exposure might develop. The introduction of a subsidy would be partly captured as a higher premium (in our example, it is completely captured by the premium)

[10] We assume that the return to capital (or the opportunity cost of capital) of the insurance companies has been included in the companies' costs when we mention that the competitive market situation is the one that makes insurance companies' profits equal or close to zero.
[11] The slight decrease of the premium after the introduction of the insurance subsidy *a priori* is the only explanation of the limited number of participants taken into account, which results in discrete calculations. This can also be the reason for the irregular shape of the profit functions in all the graphs. To this distorting factor we have to add information asymmetries, mainly the random changes in the farmers' cultivated and insured surface from 1 year to another, changes that have not been taken into account in the calculation of the WTP and the premiums.

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and therefore participation will only be marginally affected (in our example, not affected).

Despite the simple nature of our exercise, which neglects informational problems, there is an important conclusion we can draw from our study. A subsidy to the premium might promote the demand and use of all-risk insurance coverage in agriculture, provided there is sufficient competition among suppliers of insurance so that the subsidy results in effective reduction of the cost of coverage to farmers. Under nonperfect competition, part of the subsidy will be captured by the insurance industry as economic rent through an increase of the prevailing market premium, with the consequence that the introduction of the subsidy will not come up to the original expectations of promoting participation. The presence of informational asymmetries and strategic behaviour by farmers and/or insurers is not affected by the introduction of a subsidy, and therefore it would only exacerbate the problems and the distorted incidence.

The main lesson we can learn from all this is that, before even thinking of introducing a subsidy on premiums, any intervention aimed at promoting farmer participation should focus first on promoting competition among insurance providers, at the same time attempting to reduce the extent of informational asymmetries and scope for opportunistic behaviour. Only when these two objectives are achieved, devoting public resources to subsidizing insurance premiums might be beneficial to farmers.

Moreover, large number of governments have introduced a variety of programmes to encourage the adoption of Conservation Agriculture (CA) practices. With extension of services, subsidies and taxes, these initiatives have achieved some important results, for instance, the success in promoting CA practices in certain developing regions. Indeed, many programmes promoting CA throughout the world have been relatively ineffective because of contradictory signals and incentives from existing subsidy programmes. For example, policies designed to promote sustainable agriculture can be undermined by other, typically richer, policy measures such as support risk management policy. As pointed out earlier, the efforts to reform the CAP from an environmental perspective have been aimed to overcome the negative externalities associated with production supports and to incorporate positive environmental aims into the objectives of the CAP. Negatives externalities have been attacked indirectly through measures such as the nitrates directive. Undoubtedly, however, at the same time CAP aimed to sustain farmer revenue stabilization, risk management, disaster assistance or positive environmental externalities. These typologies that support agricultural initiatives conflict with each other. In this context, the overall framework of the public intervention in agriculture in Europe, should foresee a reassessment, by impede off-setting of different policies.

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