IS THERE A COMMON MODEL FOR AGRICULTURAL RISKS MANAGEMENT? COUNTRIES EXPERIENCES

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Abstract: In this paper, we present a simulation model and other modalities of reducing the risk impacts for the agricultural field, which is characterised by a strong exposure to risk. While in other sectors the main factors are economic, social and operational, agriculture has both these risks, plus the factors of weather. Applying the simulation model, individual farmers can quantify the costs and benefits of risk reducing policies and create risk-related effects on their decisions. Adapting the model for every individual farmers, they can manage the impact of risks against their production by taking properly decisions regarding the use of land and other inputs, and also with respect to government payments and other risk reduction strategies that they can use. After looking at the agricultural tools applied in America and different countries from Europe, we underline the importance of the public-private relation in sustaining of agricultural insurance. The most sophisticated agricultural insurance scheme is MPCI one used in America which can inspire the European Union one.

INTRODUCTION

The agricultural sector is characterised by a strong exposure to risk. Decision-making takes place in an environment of imperfect knowledge of the future - uncertainty - and is associated with risk which is normally defined as “uncertainty of outcomes” resulting in losses negatively affecting an individual’s welfare (Hardaker, Huirne and Anderson, 1997; Meuwissen, Huirne and Hardaker, 1999a). Historically, agricultural insurance evolved from hail insurance in the last century to other natural perils, but also business interruption and liability in this area (Baez, 2007). Thus, one of the major factors that affected agricultural markets is the weather. The large amounts of rainfall, well over the usual level all over the country, caused flooding in most counties preventing agricultural work from being done at the optimal time and resulting in lower yields for most crops.

The risks which can affect the agriculture and which are covered through insurance programs are: natural risks - including weather risks (hail, drought, flood, seismic activity) and pests and diseases; social risks - war, terrorism, looting, theft, poisoning, fire and accidents; economic risks - price fluctuations, interest rate movements and changes in demand; policy risks - trade policies including tariffs, tax policies; operational risks - personnel and timely input of material.

Natural risks are difficult to avoid and their losses are very high. A study regarding the climate change in the Europe reveals potential developments in agricultural yields and related risks (Wolfgang, 1998). This study condensed the available scientific data in two scenarios: baseline and worst case for the temperature effect, hail, drought and pest/disease (Table 1).
Table 1

Scenarios of potential climate change impacts on agricultural production and the associated risks

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Affected parameter</th>
<th>Increase by 2020</th>
<th>Increase by 2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature effect</td>
<td>mean temperature</td>
<td>0.5° C</td>
<td>1° C</td>
</tr>
<tr>
<td></td>
<td>temperature variability</td>
<td>5%</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>frequency of frost events</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>-worst case</td>
<td>mean temperature</td>
<td>1° C</td>
<td>2.5° C</td>
</tr>
<tr>
<td></td>
<td>temperature variability</td>
<td>10%</td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td>frequency of frost events</td>
<td>20%</td>
<td>30%</td>
</tr>
<tr>
<td>Hail</td>
<td>frequency of severe hail events</td>
<td>5%</td>
<td>10%</td>
</tr>
<tr>
<td>-worst case</td>
<td>frequency of severe hail events</td>
<td>10%</td>
<td>30%</td>
</tr>
<tr>
<td>Drought</td>
<td>frequency of severe drought</td>
<td>10%</td>
<td>20%</td>
</tr>
<tr>
<td>-worst case</td>
<td>frequency of severe drought</td>
<td>15%</td>
<td>30%</td>
</tr>
<tr>
<td>Pest/Disease</td>
<td>occurrence frequency for damaging levels</td>
<td>10%</td>
<td>15%</td>
</tr>
<tr>
<td>-worst case</td>
<td>occurrence frequency for damaging levels</td>
<td>20%</td>
<td>30%</td>
</tr>
</tbody>
</table>


This study points out the negative impacts of an increase in frequency and intensity of certain perils and the necessity for concrete management actions and decisions.

Climate change will have an impact on production risk as well. It is very likely that the frequencies and intensities of summer heatwaves will increase throughout Europe, likely that intense precipitation events will increase in frequency, especially in winter, and that summer drought risk will increase in Central and Southern Europe, and possible that gale frequencies will increase (Parry, 1999).

There are several reasons why it is difficult to develop insurance products to cover such risks (Skees, 1997):

- Systemic nature of the risk. If re-insurance or state guarantees are not available, the nature of the risks makes it necessary for an insurance company to charge high premia (which make the product unaffordable for many farmers) and to build up substantial capital reserves.
- Insufficient relevant historical data available to calculate a sound premium due to the infrequency of such events.
- Crowding out by Government providing ad-hoc disaster payments which stifles the development of insurance products.

**Materials and Methods**

In order to reduce the risk impacts for individual farmers, in the speciality literature it is elaborated a common simulation model used by policies in some OECD member countries. This model has as starting point an individual farmer whose profits depend on his production decisions regarding the use of land and other inputs, and also with respect to government payments and other risk reduction strategies that he can use (Anton and Giner, 2005). Profit is uncertain due to both price and yield variability, and the farmer is risk averse. The covariance between prices and yields is crucial. The model is able to capture an individual farmer’s decision in this context under risk aversion. The farmer is assumed to process information
about the distribution of the uncertain variables and its linkage with the government programmes and other risk management strategies considered.

Drawing upon expected utility theory, the farmer determines input use and degree of coverage (where appropriate) to maximise his expected utility, i.e. to maximise his certainty equivalent of profit. An initial joint distribution of prices and yields is constructed on the basis of empirical data. It is used to obtain a distribution of outcomes (profit and associated utility) that depends on production and coverage decisions made by the individual farmer and, when appropriate, on risk reducing policies in place. The model assumes an utility function of the form (see for instance Gray et al., 2004):

$$U(\tilde{\pi} + \omega) = \frac{(\tilde{\pi} + \omega)^{1-\rho}}{1-\rho},$$

with random profits $$\tilde{\pi} = \tilde{p} \times \tilde{q} \times f(L, I) - r \times L - w \times I + g(\tilde{p}, \tilde{q}, \lambda,...),$$

where:

- $$\omega$$ initial wealth;
- $$\rho$$ coefficient of relative risk aversion;
- $$\tilde{p}$$ uncertain price;
- $$\tilde{q}$$ random yield shock with $$E[\tilde{q}] = 1$$;
- $$f(L, I)$$ production function defining the expected output as function of land $$L$$ and other $$I$$;
- $$r, w$$ rental price of land and the price of other inputs;
- $$g(\tilde{p}, \tilde{q}, \lambda,...)$$ net payment or benefit from the combination of the risk strategies (indemnity net of premium).

This form for the utility function, called the power utility function, was chosen because of its desirable property constant relative risk aversion. The farmer maximises his expected utility, the mean of $$U$$ from the simulation model. The certainty equivalence of profit is used to estimate the impacts on farmer’s welfare of changes in the distribution of profits with combinations of government payments. The certainty equivalent profit is computed from the expected utility as:

$$CE = [(1 - \rho)EU(\tilde{\pi} + \omega)]^{1/\rho} - \omega.$$ 

Different programmes and strategies are defined in the function $$g(\tilde{p}, \tilde{q}, \lambda,...) = \sum_i g_i$$, that is a mathematical expression representing the indemnities or payments to be received by farmers under a combination of strategies or programmes $$g$$, net of the premium that the farmer needs to pay to use the strategies (if any). The function $$g$$ can depend on specific parameters denoted by $$\lambda$$. The list of strategies and programs analysed, together with the expressions of their indemnity functions are presented in the Table 2.

<table>
<thead>
<tr>
<th>Net indemnities for each risk reducing program or strategy</th>
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<tbody>
<tr>
<td>$$\tilde{g}_1$$ =</td>
</tr>
<tr>
<td>Price hedging, $$\tilde{g}_1$$ =</td>
</tr>
<tr>
<td>Crop insurance, $$\tilde{g}_2$$ =</td>
</tr>
<tr>
<td>Revenue insurance, $$\tilde{g}_3$$ =</td>
</tr>
<tr>
<td>Deficiency payments, $$\tilde{g}_4$$ =</td>
</tr>
</tbody>
</table>

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Where:

- \( h \) Quantity of output the farmer has decided to hedge;
- \( p_f \) Price in the futures market;
- \( Y_H \) Historical Yield;
- \( \beta_q \) Proportion of historical yield that is insured;
- \( \gamma \) Sum of the percentage administrative cost of the insurance policy and a percentage subsidy;
- \( L_I \) Insured Area;
- \( \beta_{pq} \) Revenue per bushel insured;
- \( P_L \) Target Price (Deficiency Payments);
- \( P_T \) Target Price (Area Payments countercyclical with Prices);
- \( L_H \) Historical Area of the farm.

Real programs in specific countries may not correspond exactly to this program, but some conclusions can be extracted from the stylised versions of the programs examined.

For each program or strategy, two outcomes will be studied: how a program or strategy with a given budgetary cost impacts production and how it reduces farmers’ risk. Two types of impacts on the objective function of the farmer are considered, related respectively to relative price and risk effects as defined in OECD (2001a): a program or strategy may increase the expected total returns from farming and a program may reduce the variability of returns from farming.

This model may serve to illustrate the costs and benefits of risk reducing policies and it would create risk-related effects on farmers’ decisions.

At the macroeconomic level, insurance programs and products vary from country to country in levels of government support and in the specific production perils covered, reflecting the variety of crops grown and growing conditions in the various countries.

On different markets, there are available a various risk management tools, some of the involve private-public partnership, anothers only private or only public support, as we can see in the Table 3.

### Table 3

<table>
<thead>
<tr>
<th></th>
<th>Risk absorption</th>
<th>Risk sharing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self insurance</td>
<td>Individual farming unit</td>
<td>Individual</td>
</tr>
<tr>
<td>Ad hoc disaster relief</td>
<td>Government budget/institut. aid</td>
<td>Public</td>
</tr>
<tr>
<td>Institutionalised disaster fund</td>
<td>Government budget/institut. aid</td>
<td>Public</td>
</tr>
<tr>
<td>Public insurance</td>
<td>Government budget</td>
<td>Public</td>
</tr>
<tr>
<td>Micro insurance</td>
<td>Government budget/private insurers’ capital</td>
<td>Public and private</td>
</tr>
<tr>
<td>Mutual insurance</td>
<td>Local farming cooperatives</td>
<td>Community</td>
</tr>
<tr>
<td>Commercial insurance</td>
<td>Private insurers capital</td>
<td>Private</td>
</tr>
</tbody>
</table>

Source: Swiss Re, Sigma No 1/2007, pag. 21

While the more primitive systems rely on self-insurance by farms and ad hoc disaster aid, some have adopted high performed risk management schemes as a private-public insurance partnership.

The most sophisticated agricultural insurance scheme is considered to be Multi-Peril Crop Insurance (MPCI) programme used in US (Wolfgang, 1998).
Different funds in the American MPCI system

Fig. 1

<table>
<thead>
<tr>
<th>Assigned Risk Fund</th>
<th>Development Fund</th>
<th>Commercial Fund</th>
</tr>
</thead>
<tbody>
<tr>
<td>State participation</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>Private insurers’ retention</td>
<td>65%</td>
<td>35%</td>
</tr>
</tbody>
</table>

The MPCI programme has three different levels: by paying part of the farmers’ insurance premium and reimbursing the private insurers’ expenses (state subsidies), by participation in multiple peril pools (risk allocation) and by covering private insurers’ overall retention in the pools against excessive losses (state reinsurance). State reinsurance is granted for catastrophic losses above a certain level. In the US, this three funds has proven successful in recent years.

The US program, which has grown considerably since 1995 in levels of subsidization and types of insurance available, insured about 100 different crops in 2002, covering about 75% of the planted acres of major field crops.

RESULTS AND DISCUSSIONS

Since MPCI has favourable results in the US, it may be worth considering a similar system for Europe. Still, given the diversity of agricultural, climatic, economic and political conditions among European countries, the introduction of a common insurance scheme, available for all countries of EU does not appear realistic.

In Spain, for example, multiple-peril crop yield insurance is available through a public-private system. Coverage is available for a large number of crops, including fruits and vegetables. Farmers choose the level of coverage and the perils to be covered, including “all-risk” insurance; the government provides premium subsidies and reinsurance, through Entidad Estatal de Seguros Agrarios and the Consorcio de Compensacion de Seguros. Public support accounts for around 50 percent of all costs, including administrative costs. Participation by producers in Spain in agricultural insurance is high relative to many other European countries: about 70 percent of the acres planted to cereals is insured.

Many other European countries, in contrast, have systems of agricultural insurance that receive less government subsidization and cover fewer crops than Spain. Perils covered are usually limited to a few named perils, such as hail and frost only, or coverage is limited to specific product qualities, such as sugar content for sugarbeets and starch content for potatoes.

Germany and the Netherlands have agricultural insurance products that are, in most cases, limited to hail and plant disease coverage and are operated without subsidies.

While there is considerable variation in agricultural insurance programs across Europe, they are generally smaller and more limited in scope than the MPCI program in the US.

In Romania, in order to support agricultural producers, during 2003-2005 years, the state covered the insurance premium in a 20% proportion. Starting with 2006, the state is granted a subsidy of 50% of the premium value paid to persons that contract insurances with companies approved by the Ministry of Agriculture and the Insurance Supervising Commission (ISC). This aid covers risks such as excessive dryness, hail, spring frost, flood or storm provided that the insurance premium is totally paid off until December 15 in case of fall crops and May 31 in case of spring crops. In case of damages caused by natural catastrophic...
events, agricultural producers have to bear 30% of production expenses justified by legal
documents, while the state covers the rest, which, in case of total damages can be of
maximum 70% out of which possible subsidies are deducted. Moreover, qualitative losses
were not taken into account when establishing the damages as they are 100% in the
agricultural producers’ charge.

CONCLUSIONS

Taking into account that agricultural activity is done under risk and uncertainty
circumstances as a result of natural factors influence whose unfavorable evolution can cause
significant damages to the agricultural producers, insurance is an aspect that every agricultural
producer should consider.

Adapting the simulation model for individual farmers, they can manage the impact of
risks against their production by taking properly decisions regarding the use of land and other
inputs, and also with respect to government payments and other risk reduction strategies that
they can use. The model is able to capture an individual farmer’s decision in this context
under risk aversion.

At the international level, insurance programs and products vary from country to
country in levels of government support and in the specific production perils covered,
reflecting the variety of crops grown and growing conditions in the various countries. The
most sophisticated agricultural insurance scheme is considered to be MPCI programme used
in US which can inspire the European Union one.

Still, for an international body such as the EU, the specialists suggest to implement a
framework on the basis of which each state would establish its own agricultural insurance
system with specific terms and conditions. Whthin these national systems, the public
authorities would provide reinsurance and actuarial support, allowing agricultural perils to be
comprised into insurance programmes run by private companies.

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