

CHALLENGES AND OPPORTUNITIES THE INSURANCE INDUSTRY FACING WITH IN RELATION TO CLIMATE CHANGE

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Abstract

Apart from the financial risk the insurance industry are facing with in association with climate change, there are also opportunities to the sector to develop new markets and provide coverage against weather related risks. This study presents a possible method to examine the potential for introducing a new insurance product, namely an agricultural flood insurance scheme in the United Kingdom. The investigation included the calculation of agricultural flood damage costs, the possible changes in flood risk, the description of farmers' risk attitude and interests in insurance. In a small scale survey, farmers were asked their experiences related to flooding, farm management practices and their willingness to pay for flood insurance using a contingent valuation method. Using statistical analysis it was found the insurance demand is positively correlated with the damage cost predicted and association is likely between farm types and WTP for insurance. Linear regression model suggests that the demand for flood insurance is low amongst farmers in the present risk level. The findings of this research highlight that there is little evidence for the viability of a farmer financed agricultural flood insurance scheme at the moment in the United Kingdom.

Key Words: *climate change, agriculture, insurance*

JEL Classification: Q54

1. INTRODUCTION

Climate change is one of the major challenges that the population is facing. It has several consequences: some of them are debated (increase of global temperature), while the existence of others are recognised (sea level raise, increasing number of extreme weather events). Researches show that the average annual number of these major weather related extreme events has increased worldwide from about 1.5 in the '50s to 3.7 over the last 10 years. Predictions suggest that this increasing will continue in the future (CEA, 2008).

After some serious natural hazards during the last decades there has been greater focus on the economic aspects of climate change (Posthumus and Morris, 2008). The financial losses of the five largest natural catastrophes in 2009 (Munich Re, 2010) exceeded the 14,000 million dollars, representing almost 0.001% of the 2009 American GDP (IMF, 2009). Statistics from the last decades suggest that apart from these events, floods, droughts and heat waves have also serious

economic impacts (Geneva Association, 2009) particular in Europe as well in Hungary, where floods caused more than 15 million euros of damages in 2006 (Európai Parlament, 2007).

According to the report of the LMF (2009) climate change presents the insurance industry with new challenges in two different aspects: firstly, it is necessary to adapt the changing weather patterns and other environmental effects, which generate risks. Secondly, insurance has a significant role in the mitigation of climate change as it can support and introduce policies to reduce the emission of greenhouse gases. Insurance industry needs to take on a proactive role and collaborate with other stakeholders to prevent the risks and to take the advantages arising from these issues.

This study is focusing on the role of insurance in climate change risk management. It presents a possible method to estimate the viability of climate change insurance schemes. For this purpose the non-existing agricultural flood insurance market in the United Kingdom provided a good opportunity.

2. METHODOLOGY

As the introduction suggests there are two significant variables in the estimation of demand for insurance: the risk of an undesirable weather event and individuals' WTP to be cover against that risk. Risk was defined as the probability of event occurrence multiplied by the consequences (Penning-Rowsell and Chatterton, 1977). Consequences or economic losses are different in each case but using a general formula they can be expressed as the loss in gross margins (total output less the variable costs) plus additional – such as cleaning up – costs. Combining these loss values with the probability of event occurrence risk can be got.

Individuals' WTP for an insurance product can be estimated by using contingent valuation (CV) instrument. After the hypothetical market has been set up and the elicitation method chosen respondents' WTP bids can be obtained through a survey (Garrod and Willis, 2001). Survey as a method is often used because it provides a simple approach to study of attitude, they are cheap and they can be carried out within a relatively short time period (Robson, 2002). Although the dichotomous choice approach represents the preferred method for CV (Sherrick and Barrey, 2001; Garrod and Willis, 2001) in our research open-ended questions were used, which means no values was suggested to the respondents, but to make it easier to state their bids the average damage costs per year were represented in every case. Apart from the CV instrument questions about respondents' (personal) background and experiences associated with insurance and risks could be very useful as they make it possible to examine variables that might influence to the individuals' decisions.

Survey about the agricultural flood insurance in the UK had three main parts (1. general information about farmers' background, 2. risk attitude, 3. insurance preferences). It was sent out by post and self completed. The main limitations of the research were related to this: the respond rate was around 40%, which made the statistical investigation of the data difficult.

During our research data analysis was happened through both descriptive (to show incidence) and analytical (to show relationships) statistics. Descriptive data was going to be analysed by frequency tables and percentages. It is a valuable method to describe the sample characteristics – such as distribution of different farm types, flood risk exposures and uses of fields where flood is a subject.

To find association and dependency between variables correlation and regression models were used. Table 2 gives a summary about the analysis made. However the most difficult part was to estimate farmers' willingness to pay. As a statistically significant correlation was found between WTP bids and damage cost predicted, it was decided that a sample linear regression was going to be conducted. As it was suggested (Frew et al., 2001) that the use of positive WTP values only in regression usually can yield better estimates than those in which zeros are included, zero bids were excluded in the regression analysis. Linear regression method requires some assumptions; therefore the test of the variables was necessary. This included the analysis of residuals in order to investigate their performance - such as their distribution. If some of their parameters are not matched with the requirements (see assumption column in the table) transformation of the data will be necessary. After the residual analysis it was found that application of box cox transformation is required in order to reduce the number of outliers and improve the distribution of residuals, thereby get a better, more significant regression model (Lewis and Mathieu, 1999).

Table 1 Summary of data analysis used during the research

Variables	Purpose	Method used	Assumptions of the method
Risk tolerance, farm type, land uses, flood frequencies	Determine the sample characteristics	Descriptive statistics, frequency tables	-
Summer and winter risk tolerance	Determine any significant difference	Paired t test	1. the variables are paired or match each other somehow
WTP, damage cost	Identify any association	Bivariate correlation (Pearson)	1. normally distributed variables
WTP, damage cost	Investigate how well damage cost (independent variable) predict farmers' WTP bids (dependent variable)	Simple linear regression	1. the errors of the observations are independent 2. errors are normal distributed 3. the mean of the distribution of the errors is 0, that implies: $y = \beta_0 + \beta_1x$, where y is the dependent variable, x is the independent and β is the constant 4. the variance of the errors is equal to a constant for all independent values (x)

3. RESULTS

This part presents the outcomes of the research. This includes the estimation of flood damage costs, findings about farmers risk attitude and willingness to pay for insurances.

3.1. Estimation of flood damage cost

The theoretical background of agricultural flood loss estimation (Penning-Rowsell and Chatterton, 1977) says that the cost of an infrequent flood event can be defined as the loss of gross margins adjusted by the savings, but costs could be higher as the harvest is coming. Table 3 below based on gross margin calculations and shows the estimated flood damage costs in different land uses. The magnitude of costs is influenced by many factors; this is just a broad framework of estimation with several limitations, therefore it should be treated with cautions.

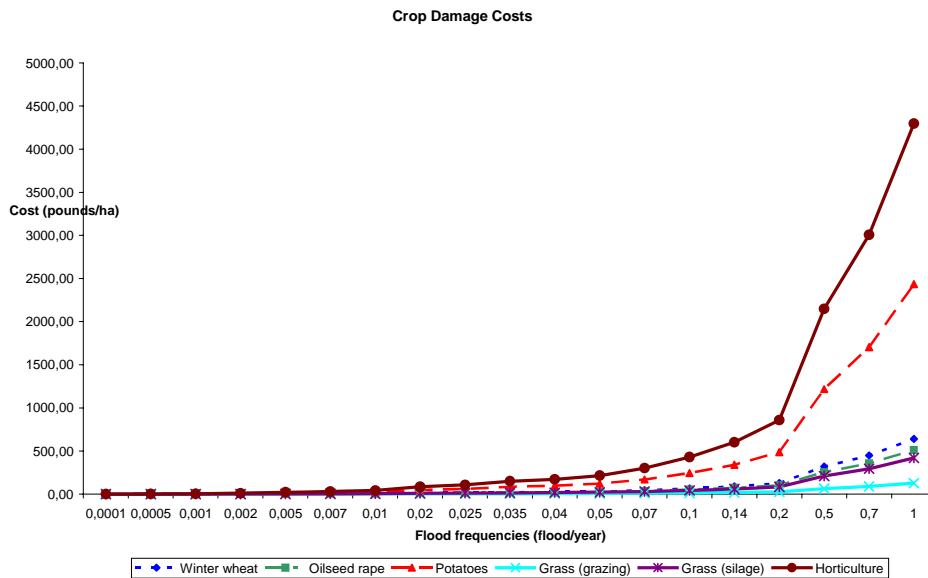
Table 2 Gross margins (£/ha) for selected crops to estimate the flood damages in different land uses

£, 2009 values		Crops					
		Winter cereals	Oilseed rape	Potatoes	Grassland (grazing)*	Grassland (silage)*	Horticulture
Yield	t/ha	8.25	3.25	45	10	10	
Price	£/t	135	300	121	47	470	
Output	£/ha	1113.75	975	5445	470	470	
Straw and by products	£/ha	40	0	0	0	0	0
Gross Output	£/ha	1153.75	975	5445	470	470	5735
Variable Cost	£/ha	511	465	3010	343	50	1466
Other crop costs	£/ha	2.7	0	0	0	0	0
Total variable cost	£/ha	513.7	465	3010	343	50	1466
Gross Margin	£/ha	640.05	510	2435	298.5	420	4269

Based upon: Nix, 2008

The highest gross margins can be found in horticultural cropping and vegetables (potatoes) that forecasts that the highest losses can be expected in these land types. Figure 1 below combines the gross margin values with different flood frequency levels and demonstrates the estimated cost of agricultural damages in some cases. Curves demonstrate the costs of total damages (100% loss in gross margins) at the flood frequency given, while the area under the curves demonstrates the risks of flooding in different land uses and flood frequencies. It can be seen that costs are proportionately lower for grassland, winter wheat and oilseed rape than for horticulture and potatoes. It might influence to farmers' land management practices as if they are growing potatoes on a field where flood is more frequent, they can suffer higher losses than if that field would be used for wheat production or as pasture (grass).

Figure 1 Agricultural Flood Damage Costs Estimated for Selected Crops and Flood Frequencies



Based upon: Nix, 2008

3.2. Relationship between flood frequencies and land uses, and farmers' risk tolerance

Based on the outcomes of flood loss estimations it can be assumed that farmers could influence their exposure to flood risk by land management practices. To investigate whether there is a special pattern in land use related to the flood frequencies descriptive statistics were used. Although it could not be proven statistically – with correlation matrix - due to the small sample size, frequency tables suggest that the more often flooded fields are usually used for pastures (grass), followed by cereals, oilseed rape, roots and vegetables, horticulture with decreasing flood frequencies. For example while 60% of the grasslands can be found on those fields that are flooded more than once per a year, then almost half of the cereals are flooded once or even less than once in every five year. Fields least affected by floods are usually used for vegetables growing or horticulture. With other words, experiences suggest that there is a converse relationship between the crop values and flood frequencies on the fields. Farmers are growing less valued crops on flood frequent fields and more valued crops on less affected fields. This shows that farmers are taking actions to reduce their exposure to flood risk and this, again could reduce the need for agricultural flood insurance.

Survey participants were also asked about their summer and winter risk tolerance in order to investigate the relationships between risk tolerance, seasonality, crop values, farm types and actual flood risk. Again, sample size made it impossible to prove statistically significant relationship, but some tendencies could be drawn. The answers indicate that flood risk is more tolerated in less valued crops – such as grass, and farmers tolerate less floods in higher valued

crops – example roots and vegetables. These results are consistent with those found in actual land uses and flood frequencies.

The mean of risk tolerance was found lower in the summer (0.3371) than in the winter period (0.5679). It means that on average summer floods were tolerated once in every 36 months (3 years), while the winter ones were tolerated once in every 22 months (1.8 year). This difference between seasons was significant, confirmed by farmers’ comments, which highlighted that short-duration winter floods do not necessary have negative impacts on their crops.

3.3. Estimation of farmers’ willingness to pay for insurance

The demand for insurance was estimated through investigation of the relationships between annual damage cost and farmers’ WTP bids. The summary statistics of these two variables indicates that the total number of observations was 80 in both variables. The large proportion of zero WTP bids (41%) shows, that farmers would not pay for insurance in almost half of the cases (most likely when the damage costs were below £60), while their highest bid was £200. They are willing to pay £20.03 on average.

To investigate if there was a statistically significant association between farmers’ WTP bids and the annual damage costs, a correlation was computed, $r(80) = 0.7206$, $p = 0.000$. Therefore it could be assumed that the direction of the correlation was positive and significant at the 0.001 level, which means that there is usually a higher willingness to pay at higher predicted damage costs and vice versa.

After the confirmation of association between the variables the next step was to investigate how well damage costs predicted farmers’ WTP bids. In order to do this linear regression was conducted. Table 4 below shows the outcome of the regression analysis with the transformed variables (box cox transformation, see methodology). A positive association between expressed WTP and expected damage cost is evident (R Square = 0.4272, $F = 33.556$, $p < .001$). The r square value indicates a large or larger than typical effect. It means that although damage cost is not the only factor that influences farmers’ decisions, their WTP bids can be estimated quite well from the loss values (it is consistent with the high B value of the damage cost in the model). The equation found is $WTP = 0.0237 + 0.4255 * \text{Damage Cost}$.

Table 3 Results of the Regression Model of Damage Cost Predicted and Farmers’ Willingness to Pay

N = 47	Beta	Std. Err. Of Beta	B	Std. Err. Of B	t(45)	p-level
Intercept			0.02367	0.3597	0.0658	0.9478
Transformed Damage Cost	0.653577	0.1128	0.42551	0.07345	5.7927	0.000001

R = 0.65357 R Square = 0.4271 Adjusted R Square = 0.4144
 F (1, 45) = 33.556 P = 0.000 Std. Error of Estimate = 0.3543

Figure 2 Relationships Estimated between Farmers' WTP Transformed for Flood Insurance and the Flood Damage Cost Transformed

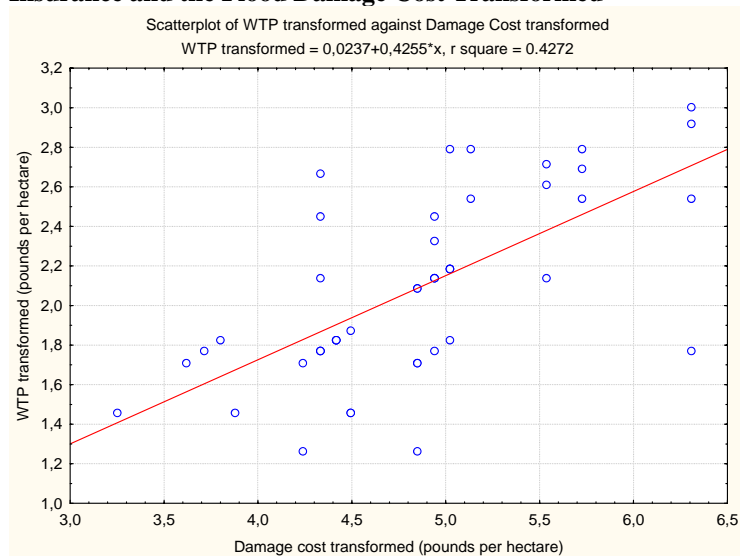


Figure 2 above shows the relationship identified between the variables. The spread of bids at the higher damage cost is quite interesting for two reasons. Firstly, because of that very low bid at £6.3 damage cost transformed. but as it was assumed that it is not an invalid data point, it had to be included in the model. Secondly it can be seen on Figure 2 that at higher damage costs (5.0 and above) farmers' WTP bids tend to be higher than the estimated values (above the red line). It suggests that at higher damage cost predicted respondents are willing to pay more in relative terms. According to Slovic (2000) this attitude – namely that respondents would pay proportionately more to avoid higher costs – characterise risk averse individuals, so it can be assumed that farmers in the sample had risk averse attitude rather than gambler.

4. CONCLUSIONS AND RECOMMENDATIONS

The research presented a possible method to estimate the role of insurance in new market opportunities related to climate change. As the case of agricultural flood insurance market in the United Kingdom suggested that although weather-related risks might be increasing the role of insurance is depending on many factors. Experiences confirmed that as far as the level of risk does not exceed costumers' risk tolerance and/or they have better opportunities to reduce their risk exposures they might be less interested in insurance policies. However these results are based on the conditions of the UK. Low WTP (interest) could be also related to low income (difficulties to pay for insurance) in other countries.

It can be also concluded that the damages related to climate change on agricultural land cannot be managed after a certain point on farm level. This statement is confirmed by the last Health Check of the Common Agricultural Policy (European Commission, 2010), where the Commission states the increase of funding for new challenges (including climate change). It is clear again that governments could also play a significant role. They can be involved in risk management in different extent: 1) provide supports to farmers to pay for insurance, when it is appropriate or 2)

compensate farmers and involve their lands in flood risk management. It is a good opportunity for further works to investigate (through cost-benefit analysis for example) the economic viability of these options.

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