Designing public-private crop insurance at the northern limit of agriculture

Petri Liesivaara[1], Miranda Meuwissen[2]

[1]MTT Agrifood Research Finland/Economic Research, Latokartanonkaari 9, FI-00790 Helsinki, Finland, E-mail: firstname.lastname@mtt.fi
[2] Business Economics, Wageningen University, The Netherlands

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Abstract

Government financed crop damage compensation (CDC) scheme is covering crop losses in Finland. The scheme is about to be abolished. Crop insurance scheme based on public–private partnership will be in place in 2016. In this study, we analysed how government expenditure will change due to the policy shift. According to a stochastic simulation model, the government's risk exposure will decrease and the mean expenditures for the government as well as the variability in expenditure between years are expected to be lower, when the policy is shifted. The results obtained support the government's decision to terminate the CDC scheme.

Keywords: government expenditures, crop insurance, stochastic simulation

1. Introduction

Adverse weather events can lead to considerable economic losses for farmers. These losses are generally compensated by governments. In Europe, the emphasis is moving from government-run programmes and disaster relief to insurances based on public–private partnership (PPP) (Meuwissen et al., 2013). In PPP, governments subsidise farmers buying yield insurance from private insurance companies. The European Union (EU) is also promoting the use of PPP in the future Common Agricultural Policy (CAP). The CAP will be reformed in 2015, and member states will be able to use premium subsidies for crop insurances based on PPP as part of rural development (EU, 2013).

The crop damage compensation (CDC) scheme was designed to cover crop losses in Finland. The CDC scheme is fully financed by the government, i.e. participation is free of charge for the farmers. The CDC scheme is to be abolished in 2016, not only due to policy shifts to PPP on the EU level, but also because of problems related to the design of the policy that attracts moral hazard (Myyrä and Pietola, 2011; Myyrä and Jauhiainen, 2012). A new risk management tool based on PPP covering crop losses should be in place in Finland from 2016 onwards.

Changing the system into a public –private partnership based on farm level crop insurance seems interesting for the Finnish government as they no longer need to cover all expenditures from the risk management scheme. It however also raises questions, among others with regard to the type of public-private partnership (e.g. premium subsidies versus some type of reinsurance agreement), where to put retention levels for the farm sector and to which extent the overall risk exposure changes due to the switch to a farm-based scheme. The switch to a public-private scheme seems beneficial for multiple reasons including incentives for good farming practices (Meuwissen et al., 2001), the uncertainty for governments may withhold the actual implementation of the partnership.

In this context, our goal was to investigate how a crop insurance scheme based on PPP and individual farm yields would affect government expenditures compared to an area-based scheme fully financed by the government. Moreover, fair premiums and the reserve loadings of the farm insurance scheme were calculated. We developed a stochastic simulation model to study the risk exposure of crop insurance based on individual farm yields in Finland. FADN data are used as input. Historical indemnities of the CDC scheme were used to define possible losses of the current system.

2. Data and method

CDC data were provided by the Information Centre of the Ministry of Agriculture and Forestry of Finland (TIKE). The data consist of payments per farm and the number of hectares lost from 1995 to 2012. The main cereal crops cultivated in Finland, i.e. barley, oats, winter and spring wheat and rye, were selected for this study. In 2012, the area cultivated with these crops represented 49% of the overall utilized agricultural area in Finland. On average, these crops account for 75% of the overall hectares lost in the CDC scheme.

The Farm Accountancy Data Network (FADN), a cross-sectional dataset, was used for analysis of the farm-based insurance scheme based on individual yield data. is an official European Union dataset that includes detailed information on farm-specific accounts. The dataset also includes crop-specific production and cultivated hectares. The farm-specific hectare yields of winter and spring wheat, rye, oats and barley were used to calculate the average indemnity payments and fair premiums of the farm yield insurance. Our FADN dataset consisted of farm yield data for 1998–2011.

Barley is the most commonly cultivated crop in terms of the average number of farms in the dataset, and also accounts for the highest average cultivated area per year on FADN farms (table 1). The average yield of cereal crops on the FADN farms is highest for winter wheat and lowest for rye.

Table 1. Descriptive statistics on the FADN dataset.

	Average cultivated hectares per farm	Average number of farms in the dataset	Average yield 1998–2011 kg/ha (std in parentheses)
Barley	20.0	512	3,283 (331)
Oats	12.3	482	3,212 (309)
Winter wheat	11.4	61	3,697 (426)
Spring wheat	18.6	206	3,592 (394)
Rye	7.5	81	2,378 (399)

The simulated insurance contract was based on individual farm yields. This structure is also promoted by the EU (EU 2013). Total indemnities I for crop c in year t of the yield insurance scheme were modelled as follows:

$$I_{ct}(\delta_{ct}) = \sum_{m=1}^{n} p_{ct} max\left[0, \left(\delta_{ct}\bar{y}_{ctm} - y_{ctm}\right)\right], \quad (1)$$

where δ is the cover of the insurance, p is the price used for indemnity calculation, $\bar{y}$ is the average yield and y is the actual yield realized on the farm m. The cover of the simulated insurance scheme was set to 70%.

The indemnities of individual farms per year for each crop were aggregated, and fair premiums F for each crop c were derived. The total premium TP_c for a crop c is the sum of the fair premium F_c and reserve loading L_c. In the literature, the event of an aggregate loss occurring that is so large that the collected insurance fund is exceeded is referred to as ruin (Bühlmann 1970). In order to minimize the probability of ruin in a given period or maximize returns subject to maintaining a specified probability of ruin, the insurance supplier collects a buffer fund L (Cummins 1991):

$$L_c = k\sigma\sqrt{N}, \tag{2}$$

where k is specified from the chosen probability $1\text{-}1/k^2$ that the insurance fund avoids a ruin. Moreover, σ is the standard deviation of the indemnity payments and N is the size of the insurance pool.

The overall indemnity *OI* of the crop insurance was calculated as the sum of the indemnities *I* for each crop *c* in a given year:

$$OI = \sum_{c=1}^{5} P_c \cdot I_c \cdot S_c. \tag{3}$$

The indemnities were estimated on the basis of the annual percentage of hectares experiencing a loss P_c, the average indemnity per crop I_c and the average number of cultivated hectares S_c of crop c in the period 1995–2012 in Finland. Average per-hectare indemnities and the number of cultivated hectares per crop were deterministic variables in the stochastic simulation model. The number of hectares lost per crop was a stochastic variable and used as an input in the simulation model of farm-based insurance. Five cumulative distributions of crop losses were constructed (c = 5) for the simulation model. Bivariate rank correlations derived from the CDC and FADN data were used as inputs in the stochastic simulation model for farm-based insurance.

Cereal crops do not significantly differ in their risk exposure to adverse weather events. The stochastic nature of crop losses among different crops was taken into account in the stochastic simulation model. Stochastic dependencies between the crop-specific cumulative distributions were estimated by Pearson's correlation coefficient, and rank correlations were specified in the simulation models.

3. Results

Mean loss hectares per year were estimated to be higher in the farm-based insurance than in the CDC scheme (table 2). In the CDC scheme, losses are more skewed to the right than in the farm-based insurance scheme. Moreover, the standard deviation and maximum losses for barley, winter wheat and rye are higher in the CDC scheme.

The simulated fair premium for barley, oats, winter wheat, spring wheat and rye was 3.6, 4.3, 5.3, 5.0 and 4.2 Euros/hectare, respectively. These amounts are on average 8% of the average indemnity payment per hectare. If the premium subsidy covers 65% of premiums, the premium as a proportion of the expected compensation is some 3%. The percentage share of average reserve loadings from fair premiums is 5.2%, 4.2%, 40.1%, 14.8% and 27.6%, respectively, when the probability of ruin is 5%. The probability of ruin reflects the probability that aggregated yearly indemnities exceed the collected premiums.

Table 2. Distribution of historical annual hectares lost (total and partial lost hectares per 1000 cultivated ha) in the CDC scheme and estimated annual hectares lost (hectares where losses exceed the 30% deductible level per 1000 cultivated ha) under the farm-based insurance scheme.

	CDC scheme			Farm-based insurance		
	Mean (std)	Skewness	Maximum value	Mean (std)	Skewness	Maximum value
Barley	23.21 (59.07)	3.3684	240.15	71.47 (50.30)	0.6068	175.85
Oats	23.17 (54.61)	2.6436	185.66	90.21 (71.60)	1.3908	305.69
Winter wheat	33.95 (98.49)	3.2536	386.03	73.44 (58.17)	0.5346	184.39
Spring wheat	49.22 (135.96)	3.3706	545.72	86.59 (131.76)	2.0501	543.43
Rye	28.18 (69.86)	2.9747	264.20	83.42 (48.52)	0.3929	163.56

The premium subsidies of the future farm-based insurance scheme will be funded solely by the Finnish government, i.e. EU subsidies will not used. The estimated average and median expenditure per year are presented in table 3. The maximum rate of premium subsidy can be 65% of the crop insurance premium (EU 2013). This percentage was used in expenditure calculations for the farm-based insurance. The simulated farm-based insurance scheme is funded by the government (65% of premiums) and farmers (35% of premiums), while the current CDC scheme is fully financed by the Finnish government. The mean government expenditure is expected to be lower in the future due to the policy shift in Finland. The mean costs from farm-based insurance would be 4.9 million Euros per year (without administrative costs). In the CDC scheme, the estimated government costs for barley, oats, winter and spring wheat and rye are on average some 5.6 million Euros per year in total.

Table 3. Mean and median costs of the farm-based insurance and CDC schemes

		Mean million Euros (std in parentheses)	Median million Euros (0.05th fractile–0.95th fractile)
CDC		5.6 (8.3)	1.3 (0.4–22.8)
Farm-based insurance	Government	3.2	2.1 (0.7–8.9)
	Farmers	1.7	1.1 (0.4–4.8)

4. Conclusions

Our research provides insights for governments into the implications of making the change from a public risk management scheme to a system involving public–private partnership and farm-based insurance. The policy switch to a public–private scheme appears beneficial for multiple reasons, including the lower average and smaller variation in budgetary expenditure for Finnish government and increased incentives for good farming practices due to improved possibilities for risk sharing. Insurance scheme also maintains incentives for risk prevention due to the retention level. The maximum possible losses from the farm-based insurance scheme are also expected to be much lower than in the CDC scheme. However, lacking knowledge of these advantages for the government may delay the actual implementation of the partnership. Thus, there is a clear demand for the results obtained with the current research.

The results obtained support the government's decision to terminate the CDC scheme. The results also form an important basis for the further development of private insurance schemes. The high variability in government expenditure will diminish, and in the future, farmers purchasing crop insurance will bear a larger share of the yield risks than under the CDC scheme.

The decision made in the EU level to promote yield insurances through rural development opens EU member states new possibilities to strengthen risk management in agriculture (Meuwissen et al. 2013). The development of yield insurances is underway in many EU member countries. Our results suggest that insurance schemes based on PPP and individual farm yields preferred to government run program with area based indemnity payment trigger. Therefore we encourage countries to develop agriculture risk management schemes that are based on PPP instead of relying on government run programs or disaster relief. The main advantage is that government expenditure is expected to be less variable under public-private insurance schemes. Moreover farm-based insurance schemes are better in dealing with asymmetric information issues.

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