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Actuarial evaluation of the EU proposed farm income stabilisation tool

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Abstract

Recently, the European Commission proposed to introduce several risk management tools in the rural development pillar 2 of the CAP. One of them consists in providing co-financing support to mutual funds compensating farmers who experience a severe drop in their farm income. This paper analyses this new farm income stabilization tool for the Walloon region in Belgium, considering separately three groups of farms (crop, dairy and cattle farms). Relying on FADN data from 1997 to 2007, this analysis focuses on estimating the probability that such regional mutual funds would need to intervene to compensate farm net incomes and, in that case, the expected amount of each farm income compensation and the total expected amount of compensation. The budgetary compensation that would be required if an income insurance scheme was implemented to compensate Walloon farmers for their income losses is evaluated. Particular attention is paid to the cyclical pattern as well as to additional requirements that could be imposed to the EU income stabilisation tool.

Keywords: agricultural risk management, income stabilisation, Belgium, European Union

JEL classification: D81, Q12, Q18.

INTRODUCTION AND MOTIVATION

Among the European Union (EU)'s legislative proposals for the Common Agricultural Policy (CAP) after 2013, several new risk management tools are introduced in the rural development pillar 2 of the CAP as a response to greater price and yield variability (European Commission, 2011). One of them presented as an income stabilisation tool consists in providing co-financing support to mutual funds that would offer compensation to farmers who experience a severe drop in their farm income. If farm income drops by at least 30% below a three-year average figure, then the mutual fund would reimburse for not more than 70% of the farm losses. It is proposed that the rural development pillar 2 would contribute to these mutual funds at the rate of 0.65 euro for every 1 euro paid into the mutual fund by farmers and cover up to 65% of eligible costs. The current proposal leaves member states to define the rules for the constitution and management of such mutual funds. It is therefore too early to know whether participation to these mutual funds would be made on a voluntary or compulsory basis and delineated according to some criteria, such as farm type and geographic location.

This proposed whole-farm income stabilisation tool (IST) has several advantages. First, it is meant to provide an overall coverage to all farm risks. Farmers generally prefer to insure their whole-farm income than separate components of their income such as the yield or the revenue of a particular activity, as they see it closer to optimising their own economic well- being

(Meuwissen et al., 2003). Combining all farm's insurable risks into a single contract provides a more efficient coverage than sorting them out into separate contracts when farm's risks do not perfectly covariate (Mahul and Wright, 2003 and Diaz-Caneja and Garrido, 2009). Indemnities from as well as financial contributions to the mutual fund are most likely to be lower compared to other risk management tools that would cover specific farm risks that are not perfectly correlated. Second, it is meant to cover severe if not catastrophic farm income risks that are most likely to be systematic within the same region where the mutual fund acts. For such risks there are reasons for a public support (Meuwissen et al. 2003). The systematic character of the risks covered justifies some form of public intervention as insurers may be reluctant to enter such income insurance market. The severity of the risks also justifies some public intervention when the marginal utility of the income assistance is particularly high in case of low incomes and the political pressure on public authorities to intervene is soaring. Targeting public support on mutual funds that cover systematic and severe risks are therefore less likely to generate those crowding-out effects that are expected when subsidised income stabilisation programmes interfere with other risk management strategies or insurance markets.

The proposed IST is purposely designed to be classified as green box compatible with the Uruguay Round Agreement on Agriculture (URAA) of the World Trade Organization (WTO, 1994) since it supports mutual funds that release compensation payments to participants only in case of an income loss exceeding 30% of a three-year average gross or net income in the preceding three-year period or, alternatively, a three-year average based on the preceding five-year period, excluding the highest and the lowest entry. Those compensation payments are also not exceeding 70% of the income loss. As such, the proposed IST shares several features of the Canadian AgriStability income stabilisation programme except that this programme does not use mutual funds to channel its support. Instead, the Canadian federal government directly covers its share of the individual farm income losses. There is a participation fee to the programme but at a low rate of CAD 3.80/CAD 1000 of the individual reference income. Finally, the proposed IST is well targeted to the individual income situations compared to other income related payments linked to aggregate indicator or index such as revenue, price or yield at the regional or national level, since its compensation payments are triggered when participants actually experience low income. This well targeting, however, brings several implementation problems that are more detailed in (OECD, 2011).

The main problem of the whole-farm approach of the IST stems from the requirement to measure and collect accurately the farm income in a manner that avoids moral hazard and is acceptable for the management of the mutual fund. The Canadian AgriStability programme collects farm income information through the income tax system with supplementary information from farmers and the Farm Financial Survey (Anton et al., 2011). Such reliable sources of information on the farm income situation are hardly available in a systematic manner at the individual farm level for most EU member states. Associated with the problem of measuring farm income is the delay between the incidence of low farm income and the actual compensation. Late compensation can be particularly detrimental to the survival of the farm for severe income losses that require a prompt response. The proposed whole-farm income stabilisation tool (IST) has also the unavoidable problem of moral hazard due to changing incentives when individual outcomes are used to trigger compensation payments. This may eventually lead to crowding out risk management strategies at the farm level and give incentives to farmers to take on more risks that can yield higher returns (OECD, 2011). Moral hazard is likely to be more prominent for this proposed IST where variability in farm incomes results from many various management decisions, not only from accidental and unintentional losses. One solution to lessen this typical moral hazard problem consists in making participation costs dependable on behaviour thanks to a bonus-malus system of counter-incentives. Other solutions consist in delineating mutual funds such that peer pressure can counter incentives towards more risky activities or adding an additional trigger for compensation based on regional references. Adverse selection can also be a problem when those participating to the mutual fund face a higher risk than those who do not, so that the expected compensation payments calculated from aggregate data underestimate their real cost.

It is, however, unclear to what extent these income stabilising mutual funds may be financially sustainable since, in contrast to the Canadian AgriStability programme, they solely rely on the financial contributions of their participants that are topped-up by financial contributions from the rural development pillar 2 at a fixed proportion. Following a preliminary evaluation of the European Commission (European Commission, 2009), it is generally reported that such an income stabilisation scheme would be costly. For instance, in year 2006, 25% of EU-15 farms suffered an income loss greater that 30% and the total compensation for these farms would have amounted to approximately 9.9 billion euro if 70% of the loss would be compensated.

In this paper we focus on estimating the expected proportion of the farms being indemnified with confidence intervals for a typical regional mutual fund and, in that event, the expected indemnity per farm and the expected aggregated farm indemnity with confidence intervals. To generate confidence intervals to these three indicators we use an econometric model that decomposes farm incomes into a farm-specific effect, a time-specific effect, some control variables, and a random residual effect. That econometric model is applied for both validation and prediction as explained in the remaining text. We emphasize that this analysis of a typical income stabilisation mutual fund does not aim at estimating the full operational cost of it, neither pricing the financial contributions to cover its cost. The full operational cost depends closely on numerous management specificities of the mutual fund that are not yet decided. Estimates that we generate are however a preliminary step in that direction. Some suggestions on pricing are outlined at the end of the paper.

After this introductive section, the next section of the paper briefly outlines the general approach. The third section specifies the farm data and the econometric model. The fourth section uses that model for validation and prediction. The fifth section discusses the results and ends with some recommendations.

GENERAL APPROACH

In the current paper, individual farm data from Belgium is used to evaluate the income risk faced by farms. It is a well-known fact now that the evaluation of this kind of risk requires farm-level considerations since the aggregated data (region- or country-level) be misleading (Coble et al., 2007). A model is calibrated by using this empirical information and used to simulate individual farm income trajectories. Based on these simulations and information from past years, the validity of the model is assessed and the model is used to predict farm incomes for the future. Finally, this stochastic information is used to evaluate the new whole-farm income stabilisation tool proposed by the European Commission.

The model considered belongs to the general class of linear mixed models (McCulloch et al., 2008). These models are useful in a wide variety of disciplines including econometrics and social sciences. More specifically, they can be used in settings where repeated measurements are made on the same statistical units and when partial information is missing in the data set (Verbeke and Molenberghs, 2000). The model allows us to control for some characteristics of the farm and to decompose the total risk in three categories: (i) systematic risk affecting all units (e.g. market risk which impacts the price variable) (ii) farm-specific risk (e.g. production risk), and (iii) random risk.

To obtain predictions, the a posteriori distribution of the income given past information is evaluated using conditional property of the Multivariate Normal distribution (Härdle and Simar, 2007).

MODELLING FARM-SPECIFIC INCOME TRAJECTORIES

1. The data set

Because the management of the rural development pillar 2 is often decentralized at the regional level, this paper analyses the new farm income stabilization tool for one particular European region, the Region of Wallonia in Belgium. We use the observations for Walloon farms included in the Farm Accountancy Data Network (FADN) from 1997 to 2007. Before decomposing farm incomes according to main risk sources, let us briefly describe the data set at our disposal.

The *class of farming* is known to have an influence on income variability. This is why we split the population of farms in three categories: crop, dairy and cattle farms, as if we establish three regional mutual funds, one for each farm type in the Walloon region.

The *farm net value added* (FNVA) measures the amount available for remuneration of the fixed production factors (work, land and capital). It has been adopted by the European Commission in the context of the income stabilisation tool proposal because it is the most comparable indicator between member states. Whether production factors are external of family factors does not modify the net value added.[1] Note that net value added is here measured on a per farm basis and that all incomes are expressed in current euro, without any adjustment for inflation.

The frequency weights obtained from the FADN data that indicate how many similar farms are included in the total population are used for estimation and simulation. Criteria that define similarity include region, type of farm and economic size class. Using these weights during estimation improves efficiency (Greene, 2011) and using them during simulations allows to extrapolating the results to the entire Walloon region. Weights are corrected following the removal from the dataset of farms with fewer than three successive entries. Table 1 provides the number of farms in the FADN database and the total population per class of farming for 2007.

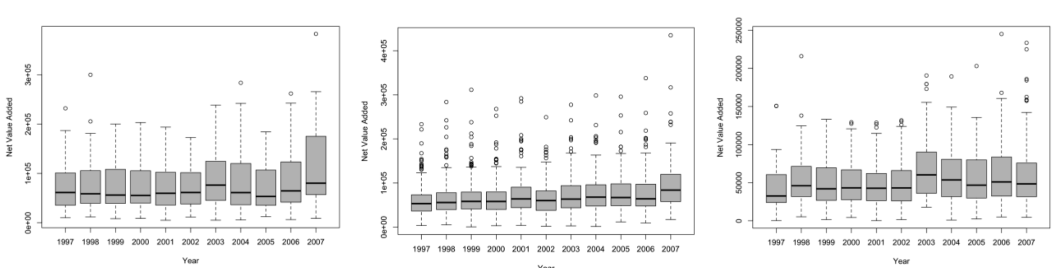
Table 1: Number of farms in the FADN database and in the total population for 2007

Type of farming	Sample (FADN database)	Population (Wallonia)
Crop (TF 1310, 1410, 1420 and 1443)	32	2520
Dairy (TF 4110, 4120 and 4310)	156	3770
Cattle (TF 4210, 4220 and 4320)	76	3700
Total	264	9990

Source: FADN

Figure 1 displays box-plots for each calendar year and each class of farming summarizing the corresponding net value added or income distributions. Median farm incomes are displayed for each calendar year, surrounded by the second and third quartiles defining the central box. This indicates income range excluding the 25% of farms with the lowest income and 25% with the highest income. Figure 1 reveals an increasing trend as well as a cyclic behaviour that may be due to natural events affecting production or movements in prices.

Figure 1. Box plots for farm's incomes, crop (left), dairy (middle) and cattle (right) farms



Source: FADN

[1] Instead of the net value added, we could also consider the gross revenue which has the great advantage of being easier to determine. We discuss the impact of the definition of revenues in the closing section. The income variables selected for calculating farmers' compensation turn out to have a significant impact on the total amount of compensation.

The size of the farm is also important and this is reflected in the information incorporated in the model. Specifically, explanatory variables include:

type of farm (TF) which is a categorical variable representing the economic-technological orientation of the farm.

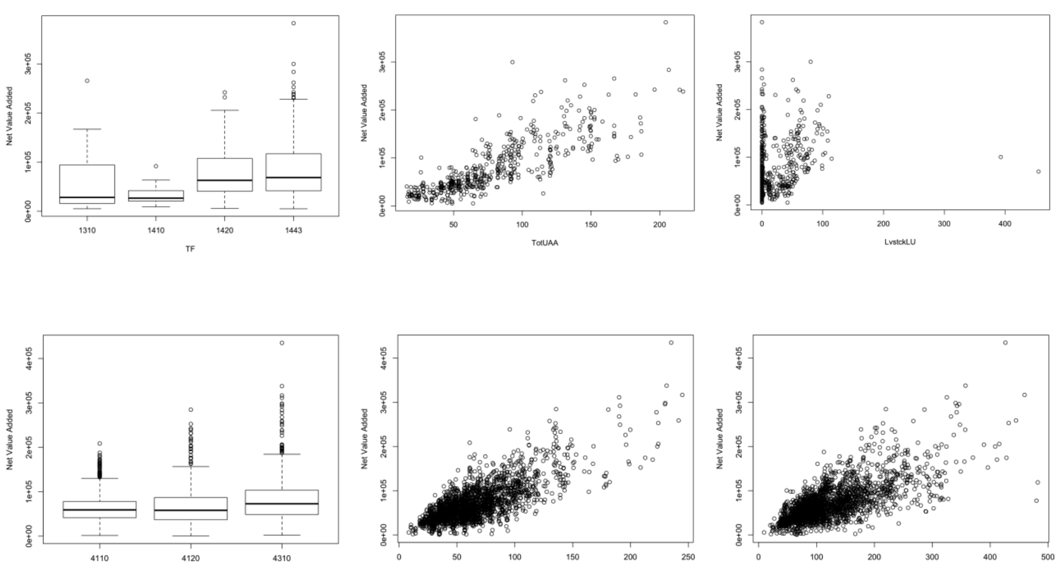
total utilized agricultural area (UAA) of holding (TotUAA) and its square: it consists of land in owner occupation, rented land and land in share-cropping. It includes agricultural land temporarily not under cultivation for agricultural reasons or being withdrawn from production as part of agricultural policy measures. It is expressed in hectares (10,000 m2).

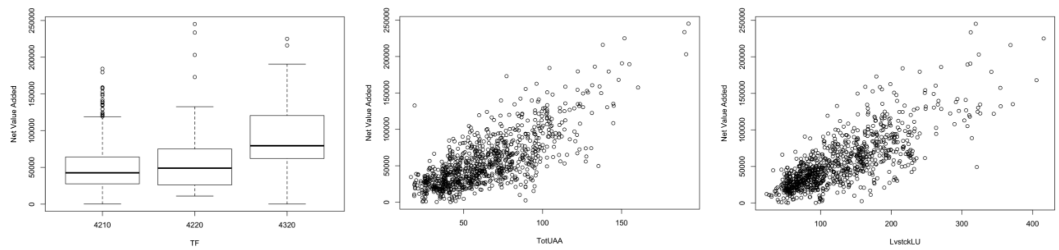
Livestock units (LvstckLU) and its square: number of equines, cattle, sheep, goats, pigs and poultry present on holding (annual average), converted into livestock units (LU). Animals which do not belong to the holder but are held under a production contract are taken into account according to their annual presence.

Number of dairy cows (DryCws), that is, female bovine animals, including female buffaloes, which have calved and are held principally for milk production for human consumption, is also included for dairy farms only.

Figure 2 illustrates relations between farm incomes and explanatory variables for crop, dairy and cattle farms respectively.

Figure 2: Relations between crop farm (top), dairy farm (middle) and cattle farm (bottom) incomes and explanatory variables





Source: FADN

2. *The farm-specific income trajectories model*

In the current paper, we restrict our attention to the net value added but a similar model could be developped for the gross revenue. To model the income for farm f at moment t (denoted as R_{ft}), we consider a four-component model:

- a fixed part in order to take into account the size of the farm;
- a systematic risk impacting all the farms of a given class at moment t (denoted as SR_t);
- an unobservable risk level Θ_f specific to farm f; and
- independent and identically distributed error term ε_{ft} reflecting random variations.

We adopt here an additive decomposition of the farm's annual income (Miranda, 1991), extended to a panel setting including time-varying covariates, that is, we decompose R_{ft} into

$$R_{ft} = \beta_0 + \sum \beta_j x_{fjt} + SR_t + \Theta_f + \varepsilon_{ft}$$

where

- we define t = 0 for calendar year 1997;
- the vector of explanatory variables $(x_{ft1},\ldots,x_{ftp})$ summarizes the observable characteristics of farm f at moment t, whose impact on the income is quantified by the corresponding regression coefficients $\beta_1, \ldots, \beta_p$ together with an intercept β_0;
- the variables SR_1, SR_2, ... describe the evolution of the systematic risk, affecting all the farms at a given moment t;
- the random effect Θ_f represents the unknown risk level specific to farm f, that is, the effect of all the farm's characteristics not included in the explanatory variables; and
- the error terms ε_{ft} account for random departures from model predictions.

Based on Figure 1, we assume that the dynamic of the systematic risk is described by a linear trend and a seasonal component accounting for possible cycles, that is,

$$SR_t = \alpha_1 t + \alpha_2 \sin(2\pi t/c) + \alpha_3 \cos(2\pi t/c) + \Lambda_t.$$

Here, the parameter α_1 accounts for the linear trend and the parameters α_2 and α_3 control the cycle of length c. The random variables Λ_1, Λ_2, … are independent and identically distributed, with zero mean and common variance σ_Λ^2. One should note that random variable Λ_t

is common to all the farms at a given moment t and represents the systematic, or non-diversifiable, risk. In few words, it is a risk which is common to an entire class of farming and cannot be diversified across farms. In the current paper, we assume that Λ_t^{Crop}, Λ_t^{Dairy} and Λ_t^{Cattle} are non correlated, but a more general model where covariance terms are non-zero can be developed. Furthermore, we assume that the random variables Θ_1, Θ_2, ... are independent and identically distributed, with zero mean and common variance σ_Θ^2 . For a given farm f , the random variable Θ_f takes the same value from time t = 0 to t = T where T is the last moment of interest. This component models implicitly the dependence between incomes from a same individual by inducing time correlation in incomes. Moreover, the farm-specific effect Θ_f allows for risk evaluation including past incomes.

The random variables ε_{ft} are independent and identically distributed for all values of f and t, with zero mean and common variance σ_ε^2. Finally, all random variables are supposed to follow a Normal distribution and the sequence of SR_t, the sequence of Θ_f and the array of ε_{ft} are mutually independent.

VALIDATION AND PREDICTION

1. Estimation of the farm income trajectories

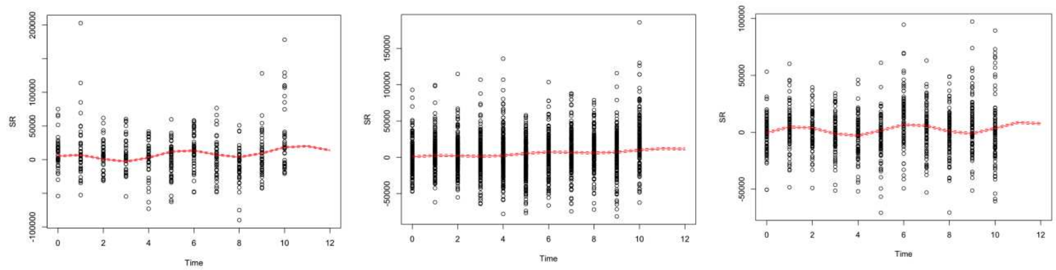
First, all parameters of the model are estimated in a one step procedure using maximum likelihood method. Estimation results for systematic risk are presented in Table 2 for the three categories of farm. The cycle length for crop, dairy and cattle farms is five years and the fitted systematic risk is described in Figure 3 together with its empirical counterpart. A forecast for the following two years is also depicted there.

Table 2: Estimation results (s.e.) for the systematic risk for the net value added

Component	Crop (c = 5)	Dairy (c = 5)	Cattle (c = 5)
t	1,311 (75)	936 (81)	386 (56)
sin(2πt/c)	4,211 (332)	1,593 (377)	4,652 (254)
cos(2πt/c)	5,324 (295)	735 (332)	-354 (224)
Standard deviation	655	794	518
# of observations	504	2,294	958

Source: own calculation

Figure 3: Fitted and empirical SR_t for cattle (left), dairy (middle) and crop (right) farms



Source: own calculation

In our model, we consider explanatory variables presented in Figure 2. For variables *TotUAA* and *LvstckLU*, a quadratic term is also considered in the model. The selection of the explanatory variables is performed by means of a stepwise procedure implemented with the help of statistical tests and the BIC (*Bayesian information criterion*). Estimation results are presented in Table 3. These results represent the linear effect of each explanatory variable on the expected annual income. For example, for crop farms, the expected annual income grows linearly by 1,061 for each additional hectare and by 132 for each additional livestock unit. All results are consistent with the descriptive analysis presented in Figure 2.

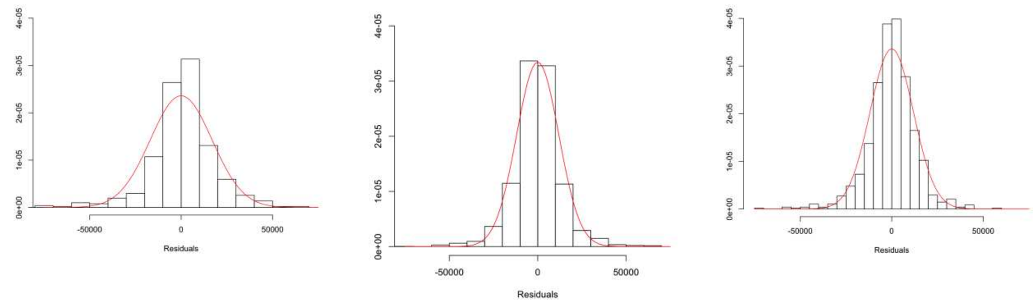
Table 3: Estimation results (s.e.) for explanatory variables for the net value added

Variable	Crop	Dairy	Cattle
Intercept	-20,882 (790)	-7,641 (598)	-11,001 (466)
TF (1410)	1,859 (703)	-	-
TF (1420)	4,894 (488)	-	-
TF (1443)	8,838 (503)	-	-
TF (4220)	-	-	6,447 (299)
TF (4320)	-	-	6,953 (283)
TotUAA	1,061 (6)	541 (7)	506 (7)
LvstckLU	132 (5)	178 (3)	246 (3)
DryCws	-	331 (7)	-
Farm-specific standard deviation	2,383	3,234	2,015
Residual standard deviation	16,900	11,937	11,867

Source: own calculation

Second, to assess the validity of the normality assumption, Figure 4 displays the histogram of the residual with a Normal density curve.

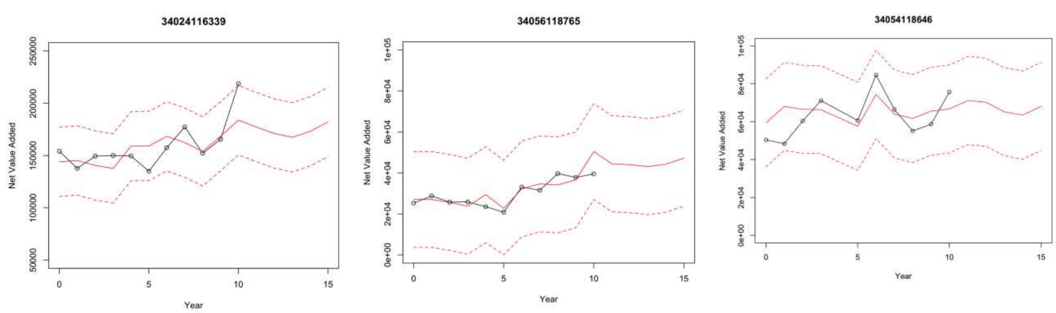
Figure 4: Histogram of the residuals for crop (left), dairy (middle) and cattle (right) farms



Source: own calculation

Third, the model can be used for fitting observed incomes and also for predicting future income trajectories for each farm. An example is displayed in Figure 5. Here, fitted values for calendar year t are obtained from $E[R_{ft}|R_{f,t-1},R_{f,t-2},...]$ conditioning on all the past observations contained in the FADN database. The predicted values for calendar years 2008-2012 are obtained in a similar way, keeping the explanatory variables as observed in 2007. Despite the fact that model tends to slightly decrease the variability of the incomes, it follows observed income trajectories.

Figure 5: Observed net value added together with fitted values over 1997-2007 and projections for 2008-2012, crop farm 34024116339 (left), dairy farm 34056118765 (middle) and cattle farm 34054118646 (right). (t = 0 for calendar year 1997)



Source: own calculation

2. *The EU income stabilization tool*

Under an income stabilization tool (IST), farmers would receive up to 70% of any income loss from a mutual fund if their income falls by at least 30% below a 3-year average figure.[2]

[2] Note that the target income is also sometimes defined as a 3-year average based on the preceding 5-year period, excluding the highest entry and the lowest entry (WTO definition, also called olympic average). In this paper, we keep the 3-year moving average to set the target income to preserve normality distribution and we do not consider this alternative definition.

These 30% and 70% thresholds are set to ensure that this new tool is classified as WTO green box compatible.

As explained in the introduction, this new tool is in line with modern risk management in agriculture focussing on whole farm income insurance programmes. In that setting, a single policy is provided, which covers global risk of jointly produced farm crop and livestock enterprises (see, e.g. Turvey, 2011).

The fact that the target income is set equal to a 3-year moving average has important consequences when incomes are subject to cycles. In the descending phase of the cycle, the IST is likely to indemnify the farmers but the benefits decrease over time as the target income diminishes. The safety net provided by the IST thus delays shocks due to cycles but does not totally protect farmers against them. It is also important to point out that the total amount of benefits paid in execution of the IST is not stable at all over time but strongly depends on the position in the cycle.

On an individual level, this feature may nevertheless be regarded as desirable since inefficient farms with decreasing incomes are not artificially supported by the IST. In fact, the 3-year moving average defining the IST target income can be considered as a form of experience rating, or bonus-malus system letting the sum insured depends on individual characteristics. We come back to this issue in the closing discussion.

Turning the IST mechanism into formulas, the target income for farm f in calendar year t is

$$\overline{R}_{ft} = (R_{f,t-1} + R_{f,t-2} + R_{f,t-3})/3$$

and the corresponding IST benefit is $B_{ft} = \max(0.7 \text{ x } (\overline{R}_{ft} - R_{ft}), 0)$ if $(R_{ft}/\overline{R}_{ft}) \leq 0.7$ and 0 otherwise.

3. *Validation of the model*

To validate the model, we simulate IST benefits for past years and we compare these stochastic results with actual values present in the database. Table 4 displays the following information for each calendar year 2005 to 2007:

- the observed proportion of farms being indemnified (i.e. those such that $(R_{ft}/\overline{R}_{ft}) \leq 0.7$ and a 99% confidence interval aroud the fitted value;
- the observed average amount of indemnity for those farms such that $(R_{ft}/\overline{R}_{ft}) \leq 0.7$ and a 99% confidence interval around the fitted value $E[B_{ft}| (R_{ft}/\overline{R}_{ft}) \leq 0.7]$; and
- the observed total amount of indemnity for all the farms in the FADN and a 99% confidence interval around the fitted value $\sum_f E[B_{ft}| (R_{ft}/\overline{R}_{ft}) \leq 0.7]$.

Results are obtained for the entire Walloon region with the help of the frequency weights obtained from the FADN database. These weights can be interpreted as the number of farms identical with respect to some characteristics to the one involved in the FADN that are present in Wallonia. Thus, if the weight w for farm f at moment t is equal to 3, for instance, we replace

R_{ft} by R_{ft}, $R(1)_{ft}$ and $R(2)_{ft}$ representing the income of the farm in the database and the two similar farms. The random variables R_{ft}, $R(1)_{ft}$ and $R(2)_{ft}$ are identically distributed and independent given the systematic risk SR_t. The total amount of compensation paid to these farms is then $B_{ft} + \sum_{k=1}^{k=w-1} B(k)_{ft}$. No observed past incomes are available for the two extra farms but the distribution of the $B(k)_{ft}$ can easily be derived from the multivariate Normal distribution for the sequence of individual revenues $R(k)_{ft}$, $R(k)_{f,t-1}$, $R(k)_{f,t-2}$, ... Due to the lack of information about these extra farms, we simply multiply the amount of benefit by the weight given in the FADN database in order to obtain results.

In each case, the observed value falls within the confidence interval constructed around the estimate. We conclude that the model can provide good predictions for the farm-specific income trajectories. One should note that confidence intervals are sometimes large and this variability reflects the complexity of the underlying process.

Table 4: Observed values and 99% confidence intervals obtained from the model for net value added

Year	Information	Crop	Dairy	Cattle
2005	Proportion	0.13 (0.05 – 0.47)	0.06 (0.03 – 0.15)	0.12 (0.11 – 0.35)
	Average	22,180 (9,204 – 33,302)	14,392 (12,403 – 24,150)	15,690 (11,978 – 23,674)
	Total	5,649,768 (2,030,004 – 20,211,190)	3,024,985 (2,040,358 – 8,903,623)	4,732,220 (4,322,187 – 15,171,819)
2006	Proportion	0.03 (0.00 – 0.32)	0.09 (0.02 – 0.15)	0.08 (0.08 – 0.36)
	Average	14,722 (0 – 46,959)	22,254 (11,623 – 24,664)	11,822 (11,660 – 22,011)
	Total	644,961 (0 – 10,019,226)	6,721,637 (1,360,682 – 8,545,502)	2,577,717 (2,556,978 – 16,533,804)
2007	Proportion	0.00 (0.00 – 0.29)	0.02 (0.01 – 0.15)	0.12 (0.03 – 0.24)
	Average	0 (0 – 48,285)	25,785 (6,586 – 28,107)	11,895 (9,957 – 22,736)
	Total	0 (0 – 10,543,231)	1,776,668 (494,210 – 7,483,420)	3,889,252 (1,626,001 – 10,341,792)

Source: own calculation

4. Prediction for 2008

We use the estimated model and characteristics of farms for year 2007 to simulate 10,000 replications of IST benefits for year 2008. Table 5 displays for calendar year 2008 the prediction for the quantities displayed in Table 4. As previously, results are for the entire Walloon region. As for validation, confidence intervals are large for prediction implying that mutual funds would need to access to large sums of money in case the actual total amount of indemnity turns out to be large for one particular year. The design of mutual funds would need to account for such uncertainty.

Table 5: Mean predicted values and 95% confidence intervals obtained from the model for net value added

Year	Information	Crop	Dairy	Cattle
2008	Proportion	0.13 (0.00 – 0.32)	0.11 (0.05 – 0.19)	0.09 (0.03 – 0.16)
	Average	7,481 (933 – 18,084)	5,182 (2,745 – 9,185)	5,389 (2,141 – 10,225)
	Total	1,683,782 (0 – 7,181,259)	2,012,989 (755,524 – 4,947,985)	1,392,817 (330,181 – 2,916,726)

Source: own calculation

In our model, predictive income distribution is computed using the farm-specific risk factor Θ_f which accumulates past experience. The a posteriori distribution of Θ_f given observed past incomes allows to revising predictions of future incomes based on available observations. The longer a farm stays in the database, the less variable its farm-specific factor Θ_f becomes.

DISCUSSION

As mentioned in the introduction, the IST proposed by the European Commission has some disadvantages. Adverse selection refers to a system in which individuals with higher risks are more likely to be selected than individuals with average risks due to partially asymmetric information. For the IST, it can be a problem because the expected compensation payments calculated from data may underestimate their real cost. Adverse selection could be efficiently counteracted by requiring compulsory participation in the system.

The IST proposed by the European Commission does not counteract moral hazard. To this end, the benefit could be modified. One possibility consists in adopting the following rule inspired from home windstorm insurance. For the policyholder to be indemnified for his damages, the wind speed as measured in the nearest meteorological station has to exceed a specified threshold, typically 100 km/h. The extra condition that could be imposed for obtaining IST benefits would be that the average loss experienced by a reference group of farmers exceeds some threshold. For instance, we could impose that

$$\sum_f R_{\mathrm{ft}} < 0.8 \sum_f \bar{R}_{\mathrm{ft}}$$

that is, that the group of farmers suffered from a loss of at least 20% compared to the aggregate target income. The IST with this additional constraint would remain WTO green box compatible and would efficiently counteract moral hazard. Note that this approach implicitly assumes that the farms have approximately the same economic size. In the limiting case where one farm dominates all the others, this kind of rule would distort competition.

A positive side effect of this kind of rule is that it can be expected to favour the emergence of private insurance contracts. Indeed, the systematic risk present in agricultural activities threatens the emergence of a viable insurance market. The additional condition proposed above confines IST to events affecting the majority of farms. This leaves diversifiable risks that could be efficiently pooled by private insurance companies.

Rejesus et al. (2006) studied the feasibility of implementing an experience-based premium rate discount system in crop insurance. In the IST, past experience enters the system in setting the target income, 70% of which playing the role of the sum insured. As discussed earlier, this may pose problems in the descending phase of the cycle but is certainly desirable to avoid maintaining inefficient farms in activity and delaying structural adjustment.

In our model, predictive income distribution is computed by means of the farm-specific risk factor Θ_f which accumulates past experience. The a posteriori distribution of Θ_f given observed past incomes allows to revising predictions of future incomes based on available observations. Contributions to the mutual fund can be based on the predictive distribution of incomes and so integrate past income trajectory. To make the system more transparent to farmers, linear credibility formulas or bonus-malus scales could be considered.

The analysis does not account for the feed-back effect of the income stabilisation mutual fund on the choice of the farm activities, which in turn may affect the cost of the mutual fund (Turvey, 2011). Variability in farm incomes may also increase further in the future as a result of the deregulation of the sector, in particular in the dairy and sugar sub-sectors. A stress test that enlarges the variance of the systematic risk can be performed for that purpose.

Let us mention that the present paper does not consider pricing revenue insurance products but confines to evaluating the amount of compensation paid in execution of the IST system. For issues related to pricing, we refer the interested reader e.g. to Stokes and Nayda (2003) and to the references therein, to Myers et al. (2005) as well as to Chambers (2007). Estimates that are generated from our model are useful for such extension.

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