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Analysis of indemnification of income risk at sector level: the case of Slovenia

Using Monte Carlo simulations, the impact of different levels of risks on indemnification through an income stabilisation tool is investigated at the sector level. The presented approach, using the IACS database, allows analyses of differences across farms with respect to farm type and farm size, applying average-based approaches. Such preliminary information is useful for policy makers responsible for the design and introduction of measures to tackle income risk issues and to identify potential beneficiary groups among farmers. The analysis shows that on average 25 per cent of farms would be indemnified annually, the majority in fruit production, the dairy sector and hop production. Mixed farm types, with a share of 34 per cent, receive only 15 per cent of the total sum of indemnity. However, if EUR 12,000 of average income is set as the threshold for participation in such a tool, only 6 per cent of farms participate and only 13.3 per cent of them would be indemnified. Indemnity at farm level would range between EUR 82 and 40,870. Taking into account all farms in the sector, the average indemnity is EUR 918 per farm and almost EUR 13,500 for the second case.

Keywords: income risk, indemnification, income stabilisation tool, IACS

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Introduction

In recent years, the concept of income stabilisation has received a great deal of attention from policy makers in the European Union (EU) (Meuwissen *et al*., 2008a). Owing to increased liberalisation and globalisation, EU farmers are increasingly exposed to competition and price volatility on agricultural markets that are causing losses in income. To help farmers cope with increased income volatility and other risks, income stabilisation mechanisms are gradually being introduced in the EU. One such attempt is the European Commission's (EC) proposal for an income stabilisation tool (IST) that could be implemented by Member States in order to provide support to farmers experiencing a severe income drop (El Benni *et al*., 2016). However, El Benni *et al*. (2016) also see the possibility of the IST becoming a new transfer instrument hampering structural changes in farming. This consideration raises the need for more empirical research to improve our understanding of the mechanisms of farm income volatility and possible indemnification for income risk.

In the launch phase of a new risk management tool, it is necessary to assess its possible effects at the aggregate sector level from different viewpoints. When evaluating ISTs from a policy maker perspective, particular emphasis is usually laid on actuarial evaluations, government costs, impacts on optimal farm programmes, and on the identification of potential beneficiary groups of farmers (Finger and El Benni, 2014a).

Three main methodological streams to analysing ISTs and risk management tools can be found in the literature. The first is the mathematical programming (MP) approach. For example, Liesivaara *et al*. (2012) applied linear programming as a part of IST analysis in Finland to explain farmers' actions. Turvey (2012) used discrete-state stochastic programming, minimising the second moment (variance). Mary *et al.* (2013a) applied dynamic stochastic programming. There are also studies utilising positive mathematical programming (e.g. Cortignani and Severini, 2012) and the quadratic programming paradigm (e.g. van Asseldonk *et al*., 2008). In most cases, optimisation is performed at the level of a whole-farm model in order to investigate how an IST affects a specific farm, representative farm or farm type (van Asseldonk *et al*., 2008; El Benni *et al*., 2016). The second most common and also most widely applied approach is stochastic simulation modelling based on Monte Carlo simulations (MCS) (e.g. Majewski *et al*., 2008; Kimura and Anton, 2011; Finger and El Benni, 2014a). The third approach is to analyse data series with regression-based econometric approaches (e.g. Pigeon *et al.*, 2014; El Benni *et al*., 2016). Long enough data series are essential for this type of analysis.

The main difference between studies analysing risk issues and those dealing with indemnification is their focus. The purpose of the first group is to test an insurance programme at the level of a farm or farm type (e.g. Turvey, 2012), while the second is to analyse the efficiency of potential income stabilisation tools at the sector level (e.g. El Benni *et al*., 2016); this also determines what kind of data are applied.

Bookkeeping data for large sets of agricultural holdings and years are commonly used for specifying potential indemnification within ISTs (El Benni *et al*., 2016). However, farm-level data are clearly needed to study or calculate indemnities at the farm level, and most studies in the EU (e.g. Meuwissen *et al*., 2008a; Vrolijk and Poppe, 2008; dell' Aquila and Camino 2012; Liesivaara *et al*., 2012; Mary *et al*., 2013a; Pigeon *et al.*, 2014) use Farm Accountancy Data Network (FADN) data for analyses of ISTs at the farm and sector level. The aim is normally not to analyse income losses at a particular farm as an insurance product, but to analyse the situation on a sample of farms. This approach allows investigation of the differences across farming types, sizes and other factors that may influence indemnification of the farmer through the IST (El Benni *et al*., 2016).

Janowicz-Lomott and Lyskawa (2014) stress that the FADN tool is not directly applicable in insurance schemes due to its selective application, as well as some technical obstacles. They argue that either a comprehensive accounting system or a reference income system needs to be implemented at farm level. Meuwissen *et al*. (2008b) stressed the need for enhancements of the FADN system that would enable better analyses and responses to farm-level risk management concerns. Liesivaara *et al*. (2012) noted the two-year time delay between current and readily calculated FADN results, which is also a drawback of the Canadian scheme (Kimura and Anton, 2011). But these points are important when the approach is supposed to be a baseline for indemnification on a particular farm, which is not the case in this study.

The approach of analysing income risks faced by groups of agricultural holdings differs significantly from that of estimating actual losses of income and calculating indemnities for a specific holding. In the latter case, farm-level bookkeeping data are necessary. An important aspect of calculating indemnities is of course the baseline for indemnification. Reference – baseline income is used to identify whether and to what extent a farmer will be indemnified from such a scheme. Finger and El Benni (2014a) analysed in detail the influence of different reference incomes on costs and the distribution of potential government support in such an income stabilisation scheme.

In this paper, an alternative approach to income loss and indemnification analysis is proposed that is based on the Integrated Administration and Control System (IACS) database. Zgajnar (2016) used this approach to investigate the level of income risk and riskiness of different farm production types. A similar approach was applied by Zgajnar (2013) in order to analyse income risks in the Slovenian pig sector. In this paper, the focus is on the probability and amount of indemnification for different farm production types and sizes. Which production types would be the main beneficiaries of such an IST in Slovenia are explored, as is the amount of indemnification at both the farm group and sector level, taking into account different levels of probability of severe income loss. The soundness of the approach of using IACS data to study indemnification is also tested.

In the next section of this paper, the modelling approach is briefly presented, and this is followed by a detailed description of how potential indemnities are estimated for each group of beneficiary farms. Then, aggregated results regarding the probability of income loss and indemnities at the farm level are presented. A rough estimation of potential indemnities is also given, indicating the main beneficiary groups in the sector. The paper concludes with an assessment of the results obtained and the approach applied.

Data description and conceptual approach

The analysis reported here focuses on indemnification through the potential IST, the primary interest being in the extent and probability of indemnification for each beneficiary group of farms. It addresses the farm, sector and national levels, and emphasis is put on severe income losses, greater than 30 per cent of average income, and potential indemnification.

On the supply side, very simple logic is applied. No additional costs of participating in such an IST are considered, since they play no role in the current 'modelling logic'. To compensate for this simplification, additional logic simulating farmers' decisions was incorporated into the model. Namely, the decision to buy an instrument for risk 'sharing' is strongly connected to risk aversion. This is a rather complex process that demands an estimation of the coefficient of risk aversion at the farm level. Mary *et al*. (2013b) solved this issue by using the average relative risk aversion coefficient but, owing to the lack of information and fundamentally different modelling paradigm in this case, such an approach was not applicable. However, the model does enable the threshold income to be selected, this being an important indirect factor influencing the decision of whether or not to buy a risk management tool.

Table 1: Farm economic size class ranges by standard output adopted in this study.

	Economic size class (SO, EUR 1,000)													
	up to 2	2-4	4-8	8-15	15-25	25-50	50-100	100-250	250-500	500-750	750-1000	1000-1500	1500-3000	3000+
Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14

Source: own construction

The simulation model is based on the Slovenian IACS database for the period 2010-2011 and includes 59,629 farms that applied for Common Agricultural Policy (CAP) Pillar 1 payments and payments for less favoured areas (LFA) in that period. In this way, information was acquired regarding the farms' main production activities and the extent to which they were conducted on a particular farm. Precise information regarding revenues from subsidies and extent of arable and grass land was also obtained. From these data it is possible to infer on the farming type and approximately estimate production volumes, yielding some information about all agricultural holdings in a particular agricultural sector. This classification and reconstruction of farms was done for the study by Rednak (2012) based on estimated standard outputs[1] (SO) methodology. Farms were divided into 21 farm types and 14 economic size classes (Table 1). Most are small farms with a diversified enterprise composition (Zgajnar, 2016).

For the purpose of this study, SOs for each activity at the farm level were calculated based on average data for the period 2005-2009, derived from internal data sources prepared by the Agricultural Institute of Slovenia (KiS). These data include information of input and output prices on monthly bases and are applied for model calculations (KiS, 2013). Forty-two basic production activities that could enter farms' production plans were defined. Using the methodology proposed by the EC (Rednak, 2012), and considering the extent of each activity, further SOs at the level of agricultural holding were calculated. An important assumption in the analysis was that the production choice remains fixed and that farmers cannot add additional production activities to the production plan in a particular year (state of nature). In that respect, it is a static stochastic analysis.

[1] The SO of agricultural production means the monetary value of output corresponding to the average situation (average values over a reference period).

Simulation model

Before analysing indemnification through an IST, the income of each farm in the sample had to be estimated. Income refers to the sum of revenues the farmer receives from the market, including any form of public support, deducting input costs (EC, 2011). The first step was to generate simulated data regarding revenues and variable costs from distributions consistent with observed prices, costs and yield dynamics, based on data prepared by the KiS (KiS, 2013), national statistics (www.stat.si) and expert estimates, while taking into account the pitfalls of data aggregation outlined by Finger (2012).

To simulate income realisation (I_{fj}) at the farm level (f) in different situations (j), e.g. different combinations of risks, a static simulation model based on the Monte Carlo simulation paradigm was used. This relies on random sampling of values for uncertain variables included in the model, based on Latin Hypercube sampling. Analytic Solver® Platform (Frontline Systems Inc., Incline Village NV, USA) was used to run the model in Microsoft™ Excel™.

Achieved income (I_{fj}) on each agricultural holding was calculated as:

$$I_{fj} = GM_{fj} - FC_f * g_f$$

where FC_f represents fixed costs per farm (f), assumed to be constant within simulations of risk. They were estimated at the level of each activity in the model as a relative share ($FC_A = SO * P_{FC}$) of an activity's standard output (SO) and summed up at farm level (FC_f). Additionally, special calibrating coefficients g_f were added to adjust the fixed costs for each farm within a particular farming type to reflect the total tillage area. This has to be done, since the same relative share was considered for particular activity (e.g. dairy) and was in that respect calibrated with regard to the size of production at each farm.

The crucial part, where risk consequences enter the model, is gross margin (GM_{fj}) achieved at the farm level:

$$GM_{fj} = \sum_{i=1}^{n} GM_{ij} + SUB$$

It is the sum of the gross margins (GM_{ij}) of all n production activities on a holding, with different values between states of nature (j). The gross margin was also increased by eligible subsidies (SUB) from Pillars 1 (including also historical payments) and 2 (LFA) of the CAP. The amounts of subsidies by which the gross margin (GM_{fj}) was increased for each farm were based on information retrieved from the IACS dataset. An important premise was that all subsidies remain constant during the simulation process.

The gross margin at the activity level (GM_{ij}) was calculated as the difference between estimated revenues (R_{ij}) and variable costs (VC_{ij}) that vary across different states of nature (j):

$$GM_{ij} = R_{ij} - VC_{ij}$$

Since most subsidies are decoupled, it was not possible to estimate revenues directly at the level of a particular activity (R_{ij}) in the farm production plan, but at the farm-level gross margin (GM_{fj}). The same approach was used for all activities in the model, meaning that the SOs for each activity were taken as the baseline for calculating revenues (R_{ij}):

$$R_{ij} = SO_i e_i a_{i,j}$$

where the calculated SO_i for each activity (i) was adjusted with an index generated from the triangular distribution ($a_{i,}$) for each state of nature j (i.e. specific combinations and probabilities of possible outcomes at activity level) reflecting the selected scenario . Based on the binomial distribution (s_1, s_2, s_3; p_{s1}, p_{s2}, p_{s3}), the model considers three different scenarios representing different levels and types of risk. The first scenario (s_1) includes 'normal risk' which means that minimum and maximum values are in the range of the 'normal' of a few years' average. The second scenario (s_2) includes greater possibilities for extremes (positive correlation between risks) than the first scenario, and the range of possible outcomes (minimum and maximum) is widened. The third scenario (s_3) anticipates catastrophic – extreme events, with significantly higher frequencies of very bad, as well as very good outcomes. e_i is a static coefficient included in order to adjust the average SO_i of each activity to each farm's characteristics, mainly with regards to economy of scale (see Zgajnar, 2016). Less emphasis is put on technological change or technological progress. Minor corrections for some technologies (e_i) were included, but it was otherwise assumed that technologies are the same for all analysed farms engaged in a certain activity.

Variable costs (VC_{ij}) were simulated at the activity level using a similar approach:

$$VC_{ij} = SO_i * P * b_{i,s,j}$$

They are defined as a percentage share (P) of SO_i. To adjust the variable costs for each state of nature (j) and each selected scenario (ss), an index generated from the triangular distribution ($b_{i,s,j}$) was included, defined by minimum, maximum and most likely values. Also for variable costs, two different scenarios (ss) were considered. They are based on the binominal distribution (ss_1, ss_2; p_{ss1}, p_{ss2}). In this case the first scenario includes 'normal risk' where minimum and maximum values are in the range of the normal few years' average. The second scenario (ss_2), as for the third revenues scenario (s_3), anticipates catastrophic events.

Evaluation of potential indemnities

Analysing potential income losses, one is interested in the likelihood of a holding's actual income falling below a certain threshold level. In the current analysis, two aspects were considered: (a) if income loss is greater or equal to 30 per cent of reference income (I_T), indemnification is triggered; (b) in such a case losses could be indemnified for no more than 70 per cent of total income loss.

Even though the EC's proposal of an income stabilisation tool (EC, 2011) states that support may be granted only when the loss of income exceeds 30 per cent of the average annual income of the individual farmer in the preceding three-year period or a three-year average based on the preceding five-year period excluding the highest and lowest entry, the average value derived from all iterations of the simulation was used. Namely, from the incomes calculated for different states of nature (I_{fj}), the reference average (expected) income (EI_f) was calculated for each farm. This value serves as a baseline for calculating the threshold level (I_T) for triggering indemnification ($Indemnity_j$):

$$I_T = EI_f * (1 - 0.3)$$

$$Indemnity_j = \begin{cases} 0; \textit{if } I_T \leq I_{fj} \\ 0.7(EI_f - I_{fj}); \textit{if } I_T > I_{fj} \end{cases}$$

So indemnification ($Indemnity_j$) for each analysed farm is only triggered when the observed income in a particular state of nature I_{fj} falls below this level. In such a case, 70 per cent of total income loss ($EI_f - I_{fj}$) in that particular year is compensated.

The manner in which the reference income level is calculated or estimated influences the indemnification significantly. Finger and El Benni (2014a) showed that not considering income trends when specifying reference income levels in such an IST may cause biases.

One of the results of this analysis is the number of cases in which farmers would be entitled to indemnification. However, it should be noted that only those farms that meet certain conditions are entitled for compensation. In practice, this means purchasing such an instrument or paying a premium. In the model, this assumption was relaxed and only farms exceeding the threshold level of average income (EI_f) were considered to participate.

A special approach was developed to assess income losses and potential indemnities. The reference income level (I_T) serves as a baseline to identify whether and by how much a farmer is indemnified in a specific (average) year. In the first step of assessing the probability of income loss and the potential indemnification concept of the IST, the model simulates income losses in 5,000 iterations for each farm in the database (59,629 in total). In the next step, which losses[2] should be considered are defined, with respect to the probability of their occurrence (percentiles). Thus, when calculating the average loss and, consequently, the average compensation, only those losses are considered that occur with a certain probability. For the purpose of this study, only those losses whose probability of occurring is greater than 20 per cent were considered. This was an arbitrarily set assumption. Such an approach reduces the expected loss of income, but the obtained solution is more stable. Namely, with this approach, events with a very low probability of occurrence and with a large impact on the expected compensations are omitted. A possible approach would be also to conduct sensitivity parametric analysis, allowing for the analysis of different scenarios in order to explore the spectrum of possible events (e.g. optimistic, average and pessimistic). In this study, the 20th percentile was used, indicating an average situation.

Using the presented approach, indemnities were estimated for each farm in the group. However, as the core purpose of this study was to analyse the characteristics of indemnification at the level of groups of farms with similar production types or economic sizes, these results were further aggregated accordingly. Thus, besides deviations for individual parameters at the farm level, differences within the analysed group of farms were also considered in the analysis.

[2] In this exercise only losses greater than 30 per cent of average income are considered.

Scenario analysis for farms participating in an IST

In addition, the difference of the average level of indemnification in different situations was outlined for illustrative purposes. A simple rule was applied regarding the participation of a particular farm in such a scheme, as well as regarding the conditions under which it would be indemnified. To show the robustness of the applied approach, two scenarios are presented with different assumptions regarding farm participation: (A) all farms achieving at least positive average income would participate, and (B) average annual realisation of income should be greater or equal to EUR 12,000 for the farm to be eligible for participation. Assumption (A) is supported by the fact that farms with negative incomes are usually treated differently, as is stressed by Liesivaara *et al*. (2012) and Finger and El Benni (2014b); thus they were omitted also from this analysis. The EUR 12,000 threshold level for scenario B was arbitrary and regarding the calculations in this paper these farms are serious business holdings employing at least one full-time person.

Results and discussion

The results relating to income losses and participation in the potential income stabilisation scheme for the Slovenian agricultural sector are presented in Table 2. Aggregate results for all 21 production types are also shown, with further division into economic size classes (Table 3). The results include both scenarios' threshold levels of average income (A and B) regarding the participation of farms in such a tool.

Almost 98 per cent of farms achieve a positive average income (Table 2) and would therefore participate in such a scheme. In that context, it should be recalled that direct payments, a major component of incomes (Severini *et al.*, 2016), are assumed to be fixed, which is also important reason for such a result. Since direct payments are considered as part of farm income, it is important to stress the finding of El Benni *et al*. (2016), which is that an area-based direct payment has a U-shaped effect. This means that such payments at first reduce and later increase the probability of a severe income drop.

Under the assumption that only income losses greater than 30 per cent of average income are considered, almost 25 per cent of farms would be eligible for indemnification. This analysis does not consider off-farm income, but it is interesting to note that El Benni *et al*. (2016) found that in the case of Swiss farms the probability of indemnification those without any off-farm income is 19 per cent and increases to 29 per cent if the share of off-farm income increases.

The largest share of farms eligible for indemnification comes from groups of farms with permanent crops (exclud-

Table 2: Farms participating in income insurance scheme and estimated indemnities for different sectors, classified according to different threshold levels A and B.

Production type	No. farms	Threshold to participate in the scheme	Sum of total indemnity (>80%)	Entitled farms	Average indemnity	Sum of total indemnity (>80%)	Entitled farms	Average indemnity
		A | B	Threshold A			Threshold B		
		%	EUR 1,000	Number	EUR	EUR 1,000	Number	EUR
11-Agriculture	4,327	0.99 | 0.03	540.68	2,015	268	90.09	11	8,190
12-Hop	90	1.00 | 0.73	1,335.92	89	15,010	1,306.57	66	19,797
13-Agriculture mixed	1,026	0.97 | 0.01	29.70	190	156	0.00	0	
14-Forage production	5,910	0.99 | 0.01	74.74	566	132	0.00	0	
P2-Vegetables	284	1.00 | 0.07	531.67	281	1,892	197.81	19	10,411
31-Vineyards	1,581	0.99 | 0.01	1,301.34	1,552	838	337.40	13	25,954
32-Fruits	1,140	1.00 | 0.10	3,029.87	1,080	2,805	1,820.11	117	15,556
33-Olive plantations	173	1.00 | 0.01	7.95	28	284	0.00	0	
34-Permanent crop mixed	584	1.00 | 0.02	613.99	470	1,306	286.12	7	40,875
41-Dairy production	5,909	0.94 | 0.33	1,771.49	1,564	1,133	106.71	22	4,850
421-Suckler cows	2,391	1.00 | 0.01	0.25	3	82	0.00	0	
422-Beef	7,436	0.99 | 0.02	187.12	520	360	18.89	4	4,723
43-Cattle mixed	5,795	0.98 | 0.02	147.37	615	240	3.74	1	3,740
44-Small ruminants	2,389	1.00 | 0.02	14.23	76	187	0.00	0	
45-Grazing animals mixed	2,169	0.99 | 0.02	24.06	168	143	0.00	0	
51-Pigs	498	0.90 | 0.10	1,109.36	445	2,493	585.14	45	13,003
52-Poultry	240	0.96 | 0.45	971.77	197	4,933	692.37	87	7,958
53-Granivores mixed	88	1.00 | 0.14	78.31	78	1,004	31.73	5	6,345
P6-Crop mixed	4,977	0.99 | 0.01	614.86	1,936	318	107.38	16	6,711
P7-Livestock mixed	3,564	0.99 | 0.03	311.40	603	516	30.26	7	4,323
P8-Mixed farming	9,058	0.99 | 0.03	1,133.87	2,587	438	359.82	26	13,839
Total	59,629		13,829.93	15,063		5,974.14	446	

Threshold A: to participate in IST, average farm income must be positive; Threshold B: to participate in IST, average farm income must be equal to or greater than EUR 12,000
Source: own data

Table 3: Sum of total indemnities (EUR 000, bold text) and share of entitled farms (per cent, italics) by farming type and economic size class under scenario A.

Type	1		2		3		4		5		6		7		8		9		10		11		12		13		14	
11	**79**	*66*	**121**	*51*	**103**	*29*	**49**	*17*	**37**	*13*	**75**	*19*	**60**	*28*	**16**	*17*	**0**	*0*	**0**	*0*			**0**	*0*	**0**	*0*		
12							**2**	*100*	**5**	*100*	**29**	*100*	**80**	*100*	**532**	*100*	**415**	*94*					**124**	*100*	**149**	*100*		
13	**6**	*22*	**11**	*18*	**7**	*12*	**5**	*22*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*												
14	**17**	*12*	**20**	*7*	**17**	*7*	**8**	*9*	**10**	*16*	**2**	*2*	**0**	*0*	**0**	*0*	**0**	*0*										
P2	**1**	*100*	**8**	*100*	**16**	*100*	**50**	*98*	**51**	*95*	**137**	*100*	**79**	*100*	**165**	*100*	**25**	*100*										
31	**8**	*92*	**48**	*98*	**135**	*99*	**196**	*99*	**236**	*100*	**228**	*100*	**96**	*96*	**47**	*100*	**34**	*100*	**36**	*100*	**55**	*100*	**74**	*100*	**110**	*100*		
32	**3**	*90*	**21**	*85*	**85**	*92*	**190**	*97*	**243**	*98*	**403**	*99*	**660**	*100*	**540**	*100*	**216**	*100*	**53**	*100*	**65**	*100*	**109**	*100*	**442**	*100*		
33	**0**	*100*	**2**	*41*	**2**	*13*	**2**	*8*	**0**	*0*	**1**	*13*																
34	**1**	*89*	**7**	*76*	**30**	*77*	**61**	*77*	**72**	*88*	**115**	*91*	**48**	*78*	**13**	*67*									**92**	*100*	**175**	*100*
41			**0**	*9*	**5**	*28*	**50**	*28*	**221**	*33*	**681**	*29*	**559**	*20*	**236**	*13*	**20**	*11*	**0**	*0*					**0**	*0*	**0**	*0*
421	**89**	*1*	**0**	*0*	**157**	*0*	**0**	*0*	**0**	*0*	**0**	*0*	**0**	*0*														
422	**3**	*17*	**10**	*7*	**25**	*5*	**40**	*6*	**35**	*9*	**40**	*12*	**19**	*12*	**17**	*20*			**0**	*0*								
43	**2**	*31*	**10**	*16*	**31**	*10*	**38**	*8*	**27**	*8*	**24**	*10*	**16**	*11*	**0**	*0*	**0**	*0*										
44	**2**	*8*	**3**	*3*	**4**	*2*	**2**	*1*	**1**	*2*	**2**	*2*	**0**	*0*	**0**	*0*												
45	**2**	*20*	**6**	*11*	**8**	*6*	**5**	*4*	**1**	*1*	**2**	*4*	**0**	*0*	**0**	*0*												
51	**0**	*71*	**2**	*69*	**6**	*77*	**26**	*96*	**60**	*93*	**241**	*90*	**353**	*92*	**280**	*88*	**71**	*100*							**69**	*100*	**0**	*0*
52	**0**	*0*	**1**	*88*	**2**	*80*	**1**	*100*	**4**	*75*	**17**	*73*	**105**	*86*	**456**	*87*	**169**	*75*	**105**	*71*			**42**	*100*	**70**	*50*	**0**	*0*
53	**1**	*94*	**2**	*82*	**4**	*100*	**4**	*90*	**3**	*100*	**5**	*100*	**4**	*50*	**39**	*88*	**16**	*67*										
P6	**28**	*44*	**86**	*35*	**118**	*38*	**72**	*39*	**50**	*56*	**91**	*57*	**108**	*70*	**36**	*71*	**26**	*100*										
P7	**1**	*25*	**10**	*19*	**22**	*11*	**41**	*16*	**43**	*25*	**61**	*26*	**65**	*41*	**51**	*37*	**0**	*0*	**17**	*100*								
P8	**24**	*66*	**73**	*39*	**160**	*24*	**170**	*21*	**102**	*20*	**137**	*20*	**123**	*24*	**118**	*36*	**22**	*40*			**38**	*100*	**0**	*0*			**169**	*100*

For definitions of economic size classes 1-14 see Table 1; for definitions of farm types see Table 2

ing olives) and granivores (Table 2). The trend is practically parallel to the average frequency of occurrence of income loss greater than 30 per cent, which is expected, as only losses greater than 30 per cent justify their consideration. The trend is similar in other production types, with some discrepancies in the groups with forage production and grazing animals without dairy.

Almost 74 per cent of these farms are classified into economic size class lower or equal to EUR 15 thousand of annual SO (EC 1 – EC 4; Table 2). These small farms receive, under scenario A, 17.4 per cent of estimated total indemnity. However, something less than EUR 5.5 million (40 per cent) of total indemnity goes to economic size classes greater than 7 (SO greater then EUR 50,000), which are larger holdings in Slovenia and account for less than 2 per cent of farms from the sample.

In scenario A, the annual total sum of average indemnities would be on average almost EUR 14 million. The average indemnity payment per farm would range between EUR 82 and 15,000, with significant differences between economic size classes within each production type (Table 3). Although these values could be much higher in a worst-case scenario, in general the average indemnity calculated at the sector level is relatively low (EUR 918) as a consequence of the large number of small farms entitled to low indemnities, as well as the very low probability (less than 20th percentile) of severe income losses (30 per cent). Even though only the sum of total indemnity per group of farms is presented in Table 3, based on the share of entitled farms from the group, the average indemnity for each group (economic size class) can be inferred. Similar results were obtained by Finger and El Benni (2014b), who found that expected indemnities are rather low compared to the average level of incomes in Switzerland and only a small number of farms would actually be indemnified in the case of an IST. Even though they applied a different approach, the findings of El Benni *et al*. (2016) are also interesting in this context. They found that farm size has no effect on the probability of indemnification, while it does have a non-linear effect on its level. The analysis reported here showed that a larger share of indemnities goes to farms within higher economic size classes.

When less likely events are taken into consideration (in the tails of the income distribution for each farm), for example lower values of percentiles, the amounts of indemnities increase rapidly. An extreme example is dairy, where the difference increases exponentially. By considering events that happen with a probability of 5 per cent or more (under assumption A), the total indemnity would increase only for dairy farms up to EUR 4.8 million.

As regards the share of total indemnity (Table 2), the majority of indemnity payments (almost 45 per cent) would go to fruit production, the dairy sector and hop production (A), which represent 18 per cent of eligible farms. On the other hand, mixed farm types (P6, P7 and P8) represent 34 per cent of entitled farms but would receive only 15 per cent of the total amount. However, this share of entitled farms drops significantly if the threshold level is increased (B). In this case, less than 6 per cent of farms exceed the threshold level and, in an average situation, fewer than 450 holdings (13.3 per cent) would be entitled annually. These farms are from the sixth or higher economic size class, which means that the annual SO is higher than 50 thousand EUR in 99 per cent of cases and higher than EUR 100 thousand in 16 per cent. Fifty-four per cent of these farms are in the seventh economic size class (EC 7) with SO between EUR 50 and 100 thousand (data available from the author upon request).

Seventy per cent of farms achieving the threshold level of income (EUR 12,000) are engaged in livestock grazing, with dairy representing more than 80 per cent of these holdings. However, the figures are very different when it comes to indemnification. Only 2.2 per cent of total payments go to farms from this group, which represent 6 per cent of entitled farms (446). In scenario B, the majority of indemnities would go to hop and fruit producers (52 per cent) and an important share (21.4 per cent) would go to granivores (pigs and poultry). In six production types, no farms are indemnified (B). This represents over 1,000 agricultural holdings, which receive 1 per cent of total indemnities under scenario A (in all these cases average indemnities are very low). The sum of total annual indemnity would decrease under scenario B (EUR 6 million), but average indemnity per farm would increase significantly, in some cases by more than thirty times (11, 31 and 34). Calculated at the sector level, the average indemnity would be about EUR 13,500. This is a consequence of the fact that farms in lower size classes do not meet the EUR 12,000 threshold and are therefore not considered.

Conclusions

The novel contribution of the approach presented in this paper is that it is based on the IACS database and therefore enables agricultural sector level analysis. Accounting data at the farm level are not needed, and a preliminary analysis of income risks and indemnification for the sector as a whole is possible. Notwithstanding that the simulations are done at the level of individual activities and aggregated at the holding level, the model is not suitable for analyses of income risks at farm level. For a detailed analysis of an individual farm's risk, it is necessary to have much more detailed data (bookkeeping records) for each farm than those used here.

Despite these strong assumptions in the current version of the model, it is suggested that the described approach gives a sufficiently reliable estimate of income risks and levels of indemnification for a group of agricultural holdings, either at the sector level or within an economic size class. The usefulness of using simulations and analysing the results lies in the improved understanding of income issues at the sector level. This approach yields information regarding the possible magnitude of potential indemnities and beneficiary groups for different sizes and sources of risk.

Even though the current EC proposal calculating expected income suggests a three-year average or a five-year Olympic average to specify the farm-level reference income, the approach adopted here is based on the averages calculated from 5,000 simulation iterations. It would therefore be interesting to analyse in further research how the figures would change if a three- or five-year average was used in the approach using the IACS database.

The results show that there are big differences in indemnities for income losses for different farm types, as well as economic size classes. On average, indemnities are relatively low. This is to some extent due to the direct payments that stabilise farm incomes as shown by Severini *et al*. (2016). Similar results were also obtained by dell'Aquila and Camino (2012), who found that the majority of farmers would receive a few thousand euro. The average indemnity is highly dependent on assumptions regarding farm participation. The average indemnity calculated at the sector level would be EUR 918 in the first case (A), and almost EUR 13,500 when only farms achieving at least EUR 12,000 of average income participate (B). A significant part of income losses is not considered in such a case due to the large share of small agricultural holdings. This finding is in line with El Benni *et al*. (2016), who found that particularly low-income farmers would be indemnified under an IST.

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