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Spatial and temporal development of subsidised crop insurance in Hungary

A díjtámogatott biztosítás térbeli és időbeli terjedése Magyarországon

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ABSTRACT

Farmers face a variety of risks, of which the most important is the production risk arising from the unpredictable nature of weather and other uncertainty factors. This paper describes the expansion in space and time of subsidised crop insurance in Hungary, particularly the government-subsidised all-risk insurance scheme. The empirical analysis was based on insurance data and utilised area from the period 2012-2016. Firstly, Moran's *I* index was applied to examine the spatial pattern of insurance use. The index shows a significant neighbourhood effect with respect to location in both the total of all subsidised, and the all-risk schemes. Secondly, using the dynamic spatial autoregressive model, the authors found that the level of insurance take-up is determined by the previous year's level, as well by production structure (i.e. arable v. fruit v. vegetable crops) and farm size. There is no statistically-significant effect of production structure and farm size on the take-up of all-risk insurance. The high level of fruit production in Hungary discourages farmer participation in the subsidised insurance scheme, implying that further refinement of the two-scheme risk management system is necessary.

Keywords: all-risk insurance, Moran's *I*, risk management, SAR model

ABSZTRAKT

A mezőgazdasági termelést számos kockázat fenyegeti, ezek közül a legkiemelkedőbb a termelési kockázat, amely leginkább a kiszámíthatatlan időjárási körülményekből fakad. A kutatásunk a díjtámogatott biztosítás térbeli és időbeli terjedését vizsgálja Magyarországon, kitérve az összkockázatú biztosítás terjedésére is. Az elemzés a 2012 és 2016 közötti időszakra vonatkozó biztosítási és területadatokra épül. Elsőként a Moran-féle *I* indexet alkalmaztuk díjtámogatott biztosítás térbeli mintázatának elemzésére. Az index szignifikáns szomszédsági hatást jelzett a teljes díjtámogatási biztosítás vonatkozásában, ezen belül az összkockázatú díjtámogatott biztosításra vonakozóan is. Ezt követően dinamikus térbeli autoregresszív modell alkalmazásával megállapítottuk, hogy az előző éves biztosítottsági szint, az üzemméret és a termelési struktúra (szántóföldi növény, gyümölcsös, ill. zöldség) is meghatározó a biztosításkötésre vonatkozóan. Az összkockázatú biztosítás esetében nincs szignifikáns hatása a termelési struktúrának és az üzemméretnek sem. A gyümölcstermesztők részvétele a díjtámogatott biztosítási rendszerben meglehetősen alacsony, ami felveti a rendszer továbbfejlesztésének szükségességét.

Kulcsszavak: kockázatkezelés, Moran-féle *I* index, összkockázatú biztosítás, SAR modell

INTRODUCTION

Farmers face a variety of risks, of which the most important is the production risk arising from the unpredictable nature of weather and other uncertainty factors (Hardaker et al., 2004). The escalating level of risk to crop producers arising from more frequent extreme weather events and climate change increases the need for more tailored risk management tools (Kemeny et al., 2012). Among these, crop insurance is one of the most important, and a variety of 'yield insurance' schemes provide cover against all the major climatic hazards, but not against losses caused by plant diseases (Bielza Diaz-Caneja et al., 2009). However, the provision of crop insurance is often not attractive to commercial insurers because of the high level of risk and the high loss ratio. Consequently, crop insurance is expensive, and most producers cannot afford to purchase it. Therefore, subsidies on premiums have an important role in increasing farmers' participation in crop insurance schemes (Kemeny and Varga, 2010). For example, Cortignani and Severini (2012) concluded that the crop revenue insurance scheme in Italy was not profitable for the insurance companies and that a market could be only developed if premiums were subsidised. Similarly, the U.S. government recognises that it has a role in maintaining and developing crop insurance schemes and prefers to support farmers' purchases of insurance ex ante rather providing disaster aid ex post (Bulut, 2017).

The EU also pays attention to risk management in crop production. The risk management toolbox is the part of the current Common Agricultural Policy (CAP, 2014-2020), as described in Regulation (EU) No 1305/2013, incorporates animal and plant insurance (Art.37), mutual funds for animal and plant diseases and environmental incidents (Art.38), and income stabilization tools (Art.39) to manage income volatility (European Commission, 2017). This toolbox is available under the second pillar. The Member States are allowed to support insurance premium up to 65 per cent in case of insurance products that compensate losses exceeding 30 per cent. This is a favorable change compared to the previous CAP period (2009-2013) when the premium support was available via the direct payment envelopes and the support of premium rates was set at maximum level of 10 percent (Meuwissen et al., 2018).

Private single peril insurance is available in the vast majority of EU Member States (Santeramo and Ramsey, 2017). The largest multi-peril crop insurance programs are in France, Spain and Italy. In Austria index-based insurance is also offered targeting drought risk to some specific crops and grassland (Meuwissen et al., 2018).

Subsidised crop insurance is available in Austria, Belgium, Croatia, France, Hungary, Italy, Lithuania, Malta, the Netherlands, Portugal and Spain. Of these, Italy and Spain have the largest programmes, which subsidise yield insurance premium up to 65 per cent, nevertheless the participation is low. Germany is the only country offering multi-peril insurance without subsidies (Santeramo and Ramsey, 2017).

In Hungary, to ensure an adequate level of risk protection for farmers, a new, subsidised, two-scheme system, covering both damage mitigation and crop insurance, was introduced by the government in 2012 (Kemeny et al., 2012). This two-scheme system is unique in EU in that farmers may receive compensation from both schemes for the same period of time. Participation in the damage mitigation scheme is compulsory[1] for all farms above a certain size[2]. Compensation is offered only if the overall losses at the farm level exceed 30% of the production value[3].

Under the crop insurance premium support scheme, the financial support cannot exceed 65% of the premium paid. Compensation from subsidised crop insurance is payable when the loss of crop yield exceeds 30% (Kemeny et al., 2014).

1 The compensation contribution is HUF 1,000 per hectare for arable crops and HUF 3,000 per hectare for fruit and vegetable crops

2 Above 10 hectares for arable crops, above 5 hectares for vegetables and above 1 hectare for fruits

3 Between 2012 and 2015 the limit was 30% but in 2016 this limit was reduced to 15%

Three types of subsidised insurance are available in Hungary and these cover different combinations of crops and natural hazards. The 'A' type (also referred to as 'all-risk') insurance covers all major natural risks – hail, storm, winter frost, spring frost, autumn frost, drought, heavy rain, flood and fire – for major arable and major fruit[4] crops. The 'B' type insurance is available specifically for vegetable crops, minor fruit[5] crops and some major arable crops, and addresses only the major risks: hail, winter frost, autumn frost, storm and fire. The 'C' type insurance covers all relevant crops for any damage not covered by insurance types 'A' and 'B'. The aim of the 'A' type insurance is to cover all relevant natural risk for the major crops. Therefore the insurance premium is the highest in this case. The 'B' and 'C' types give the choice to the farmers to specify one or more risks covered by the insurance usually at lower fees.

In year 2016 the 'A' type insurance was used by 3,253 crop producers, 'B' type by 8,398 and 'C' type by 4,623. Overall 11,193 different farmers payed for subsidized crop insurance that year. The insurance premium payed by these farmers was HUF 7,877 million. That was a huge increase compared to the 1,896 insurance contracts and HUF 1,467 million insurance fee in 2012.

The participation of farmers in crop insurance schemes is influenced by several factors, one of which is location. Adhikari et al. (2010) studied heterogeneity in decision making among US maize producers about the purchase of yield-based or revenue-based crop insurance. They found heterogeneity with clustering effects, i.e. an individual's participation was influenced by the actions of nearby farmers. This result is in line with Tobler's First Law of Geography, namely that 'everything is related to everything else, but near things are more related than distant things' (Tobler, 1970). Several other factors can affect insurance use. Goodwin (1993) found that among U.S. maize producers both the type of business and farm size have an impact; corporations and larger farms are more likely to purchase insurance. Sherrick et al. (2003) and Enjolras and Sentis (2011) also found evidence of a farm size effect among U.S. maize and soybean farmers and French famers. The difference in the cost of insurance premiums between arable, fruit and vegetable crops also has an impact on the extent of insurance take-up. Insurance premiums for fruit crops are expensive compared to arable and vegetable crops, and this reduces the willingness of farmers to buy insurance cover (Kemeny et al., 2017).

The aim of this paper is to investigate the spatio-temporal development of subsidised[6] crop insurance usage in Hungary during the first five years of the current scheme, i.e. between 2012 and 2016, with regard to both the total extent of subsidised insurance and the different insurance types, especially all-risk ('A' type) insurance. Hungary is the first post-socialist European Union Member State to implement such a scheme. By studying the factors driving the trends, policy recommendations on how the scheme can be improved can be made. Furthermore, the literature about spatial expansion of crop insurance is sparse, and this analysis can add to the available pool of knowledge on this topic.

In this paper, two separate hypotheses were tested concerning subsidised crop insurance usage in Hungary:

Hypothesis 1: The intensity of insurance use has a spatial pattern, as farmers' insurance decisions are influenced by the decisions of nearby producers.

Hypothesis 2: Crop insurance level is influenced by production structure, namely a high rate of fruit production has a negative effect, and a high rate of vegetable production has a positive effect on insurance take-up at settlement (LAU 2) level.

The spillover effect was also studied: official Hungarian data suggest that the year- on-year increase in crop insurance level has a positive effect on the take-up

4 Major top fruits (e.g. apple and pear) and grapes

5 Minor top fruits and all soft fruits

6 Non-subsidised insurance is also available to farmers in Hungary, but detailed data are not available about it. In any case, the authors were interested solely in the spread and drivers of subsidised insurance, which accounts for a very high share of all crop insurance. In 2016 this proportion was about 70% of total written premiums. Thus, non-subsidised insurance has been excluded from our analysis

of insurance, and a model was used to confirm whether or not the years' contribution is positive.

Although the exposure of the different risks varies by region, the total area of Hungary faces some weather risks. For example, hail and drought risks are high for the whole country. The hypotheses do not consider the insured weather risks, only the fact of insurance use was investigated regardless of the risks covered. The 'A' type insurance is an exception because it covers all major natural hazards. The 'B' and 'C' types insurances covers the risks the farmers choose from the options. Hail insurance is typically purchased under 'B' and 'C' types.

MATERIALS AND METHODS

The empirical analysis used crop insurance data collected by the Research Institute of Agricultural Economics (AKI) in Budapest, Hungary and utilised area data (according to the location of the farm) from the Integrated Administration and Control System (IACS) for the period 2012-2016. The data were analysed at settlement (LAU 2) level. Moran's *I* index is used to evaluate the spatial pattern of subsidised crop insurance use and the dynamic spatial autoregressive model (SAR) was used to examine the factors influencing crop insurance take-up in terms of type of insurance and percentage of eligible area insured, also taking into account the spatial relationship. Lagged insurance rate, cultivation structure (the area shares of arable, fruit and vegetable crops) and average insurable farm size (i.e. not including areas of forest and grassland) were tested. The data availability limited the analysis. Some other factors may have also have influence on insurance-take-up (e.g. income level), but only the data listed above are available for all farms with subsidised insurance. The level of income has probably some impact on insurance use but unfortunately income data are not available at the level investigated. The average farm size is the best available proxy for income level which refers to the amount of SAPS (Single Area Payment Scheme) payments. This subsidy represents a significant part of the income in case of crop producers.

Moran's I Index

The Moran's *I* index is widely used to measure the degree of spatial association for the whole data set (Cliff and Ord, 1981; Fisher and Wang, 2011). Moran's *I* uses cross-products to measure value association. Moran's *I* is given by equation (1):

$$I = \frac{n}{W_o} \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i-\bar{x})(x_j-\bar{x})}{\sum_{i=1}^{n}(x_i-\bar{x})^2} \tag{1}$$

where n is the number of settlements in the sample, i, j are area units, x_i is the value of the variable of interest for area i, W_{ij} is the weight that expresses the similarity of i's and j's locations, W_o denotes the normalising factor expressed by equation (2).

$$W_o = \sum_{i=1}^{n}\sum_{j\neq i}^{n} W_{ij} \tag{2}$$

The spatial autocorrelation test is used to examine the spatial arrangement of data values based on Moran's *I* statistic. The null hypothesis is that nearby areas do not affect each other. In contrast, under the alternative hypothesis of spatial autocorrelation, large values are surrounded by other large values (referred to as positive spatial autocorrelation) or small values are surrounded by large values (referred to as negative spatial autocorrelation). Positive spatial autocorrelation implies a spatial clustering of similar values, while negative spatial autocorrelation implies a checkerboard pattern of values. Spatial autocorrelation is considered to be present when the test statistic computed for a particular pattern takes on a large value compared to the expected value under the null hypothesis.

The Moran's *I* index was calculated for each year separately. In this case, the weight matrix used by the Moran's *I* index was calculated based on contiguity edges corners (sometimes referred to as Queens's case contiguity). Polygons that share an edge or a corner is weighted equally, and those that do not share an edge or corner are excluded from the calculation (their weight is zero).

Dynamic spatial autoregressive model

The development of spatial statistics applied to panel data provides a control for spatial and temporal dependencies simultaneously. There are several methods for fitting spatial panel models and these are divided into two categories: generalised method of moment and quasi-maximum likelihood (Baltagi, 1995; Elhorst, 2010). The dynamic spatial autoregressive model was applied (SAR) which is designed for equation (3).

$$\mathbf{y}_t = \tau \mathbf{y}_{t-1} + \rho \mathbf{W} \mathbf{y}_t + \mathbf{X}_t \boldsymbol{\beta} + \mu + \epsilon_t \quad (3)$$

where $\boldsymbol{y}_t$ is the $n \times 1$ vector describing the dependent variable, $\boldsymbol{x}_t$ is the $n \times k$ matrix of regressors, where n denotes the number of observations and $t = 1...T$ denotes the time periods, $\boldsymbol{W}$ is the $n \times n$ spatial weight matrix describing the spatial arrangement of the n units, ρ is the scalar spatial autoregressive coefficient with $|\rho| < 1$, $\boldsymbol{\beta}$ is the $k \times 1$ parameter vector of regressors, μ is the individual effect and $\in_t$ is the error term. The STATA xsmle module (Belotti et al., 2017) was used to estimate the parameters; xsmle implements only the fixed-effect variants for the dynamic SAR model using the bias-corrected quasi-maximum likelihood estimation. The spatial weight matrix was defined the same way for the Moran's *I* index: the contiguity edges corners definition was applied so that the results are comparable.

RESULTS

The total insurable crop area in Hungary, including the 'A', 'B' and 'C' type insurable areas, is about 4 million hectares. Figure 1 shows the area coverage of subsidised insurance as a percentage of the total insurable area by insurance type. The combined[7] coverage of all three types of insurance increased dramatically from 4% in 2012 to 28% in 2016. Vegetable crops achieved the largest increase in insurance level, from 5% to 36%. The level of arable crops insurance went up from 4% to 29%. The smallest change in insurance level, from 4% to 7%, was for fruit crops. The level of all-risk ('A' type) insurance increased from 2% to 7% of the total insurable area by 2016; this means that the insured area increased from 50 000 hectares to 210 000 hectares over four years.

The autors then examined the insurance situation at settlement level. In 2012, only 4% of settlements with insurable area recorded insurance levels above 20% of the eligible area but by 2016 this figure had increased to 35%. The spatial pattern of total subsidised insurance at settlement level is presented in Figure 2. In 2012, high levels of insurance occurred in only a few settlements (Figure 2a) but by 2016 the level of insurance had also increased significantly in some nearby settlements (Figure 2b).

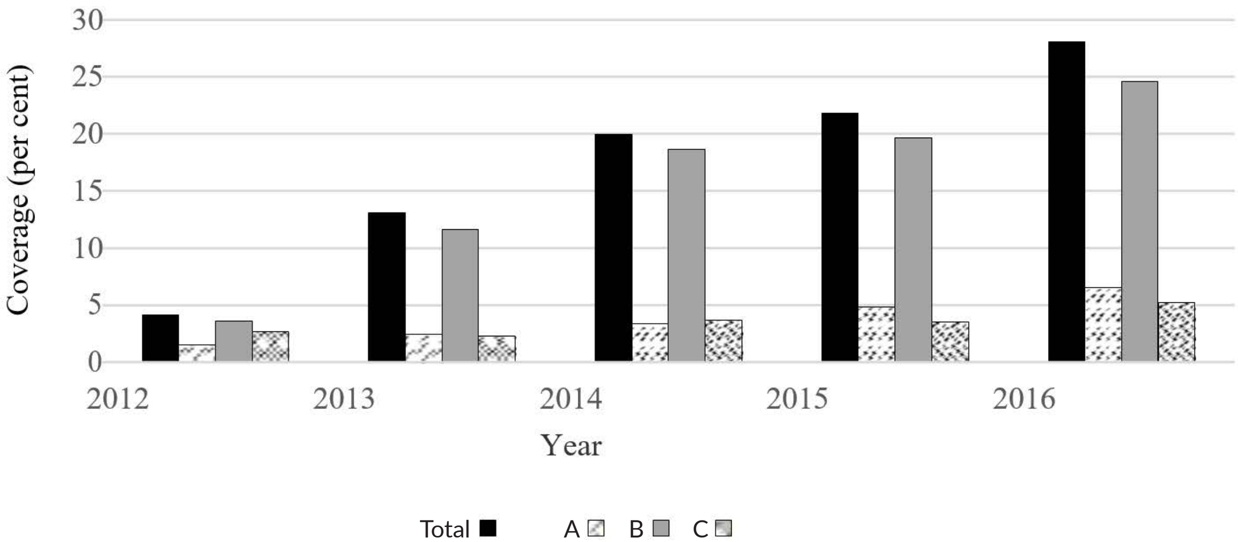
Table 1 shows the Moran's *I* statistics by year for the period 2012-2016. The Moran's *I* indexes are statistically significant at the 1% level and the z-scores are positive, meaning that the null hypothesis can be rejected globally and for each type of insurance for each year during this period. The spatial distribution of similar values in the dataset is more clustered than would be expected if the underlying spatial processes were random. For all types of subsidised insurance taken together, the Moran's *I* values increased year on year, indicating that insurance level in neighbouring settlements converged. Similarly, individual take-up of the 'B' and 'C' type insurances also became more clustered over the period 2012-2016. In contrast, the 'A' type insurance level became less clustered, although the overall take-up of this type of insurance increased.

To investigate the spatial relationship of insurance further, the SAR model was used with lagged insurance use and additional exogenous variables, such as proportions of fruit and vegetable areas, and farm size.

The descriptive statistics of settlement level variables included in the models are presented in Table 2.

The results of the SAR model are presented for total subsidised insurance and for different insurance type (Table 3).

7 For combined (all types) insurance, the reference area is the total area which can be insured by 'A', 'B' or 'C' type insurances. By contrast, the reference area for 'A' type insurance is only the 'A' insurable area, for 'B' is only the 'B' insurable area and for 'C' is only the 'C' insurable area. For example, oilseed rape can be included in 'A' but not in 'B' type insurance, therefore the oilseed rape area is included in the 'A' and 'C' types and combined insurance levels, and excluded from the 'B' type insurance level



Source: own calculations based on NAIK AKI data

Figure 1. Area coverage by subsidised crop insurance type in Hungary between 2012 and 2016, per cent

Table 1. Summary of the Moran's *I* statistics by type of insurance and year for the period 2012-2016

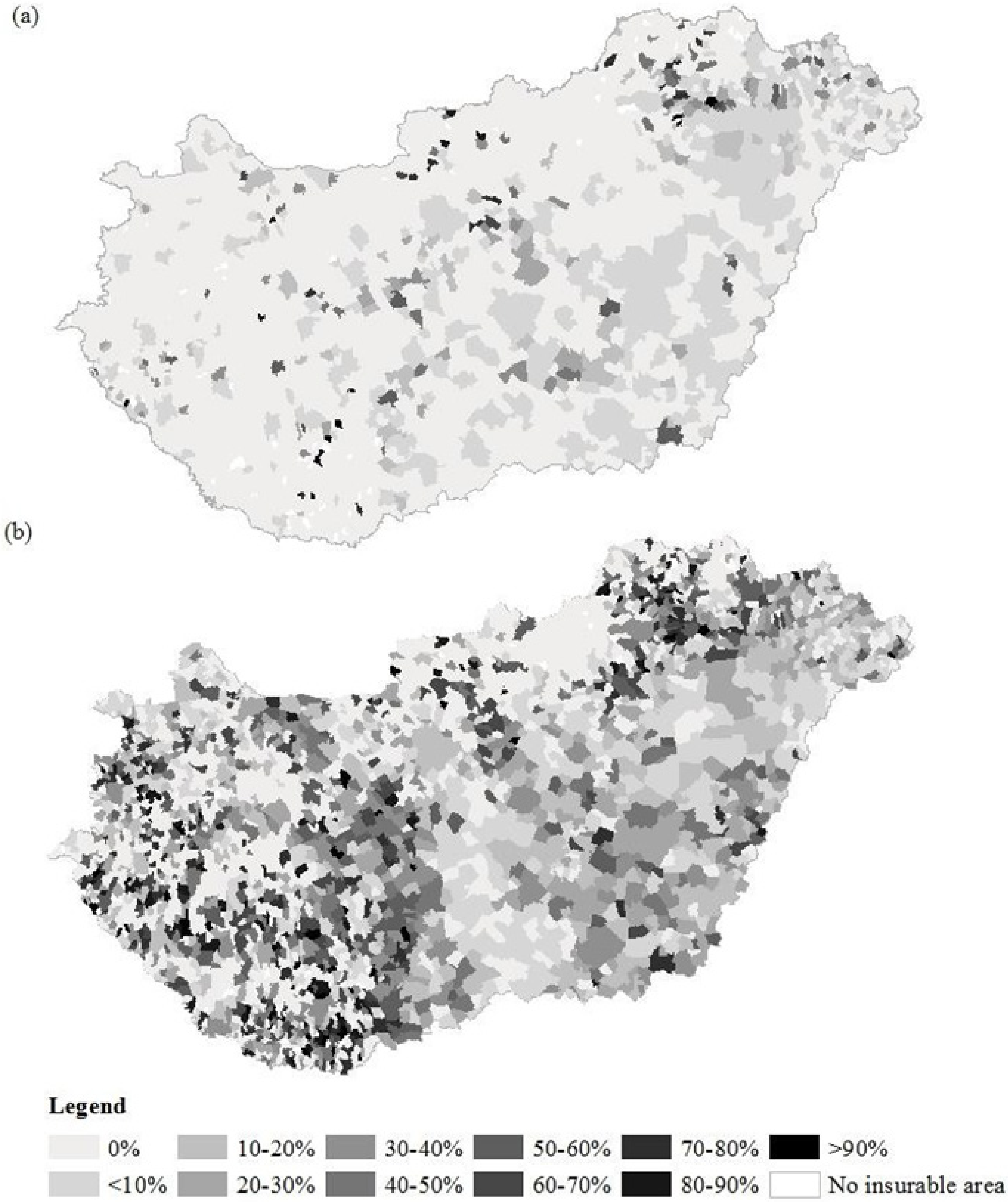
Year	All types	'A' type	'B' type	'C' type
2012	0.0943	0.1623	0.0328	0.0420
	(8.9603)	(15.4404)	(4.6129)	(4.0262)
2013	0.1274	0.1301	0.1238	0.0349
	(12.0995)	(12.3365)	(11.6788)	(3.3565)
2014	0.1449	0.1552	0.1262	0.0413
	(13.7041)	(14.6548)	(11.8559)	(3.9425)
2015	0.1544	0.1062	0.1496	0.0929
	(14.6040)	(10.0020)	(14.0146)	(8.8226)
2016	0.1834	0.0873	0.1888	0.1055
	(17.2898)	(8.1976)	(17.6555)	(9.9915)

z-scores are shown in parentheses.
Source: own calculations based on AKI and IACS dat.a

Table 2. Descriptive statistics of variables included in the dynamic spatial- autoregressive model

Variable	No. obser- vations	Mean	Std. dev.	Min.	Max.
Share of insured area (%)[1]	15,130	12.15	22.32	0.00	100.00
Share of 'A' type insured area (%)[1]	14,840	2.83	10.74	0.00	100.00
Share of 'B' type insured area (%)[1]	12,505	10.80	21.17	0.00	100.00
Share of 'C' type insured area (%)[1]	15,130	2.48	7.01	0.00	97.66
Share of fruit crop area in total area insured (%)	15,130	6.11	14.49	0.00	100.00
Share of vegetable crop area in total area insured (%)	15,130	1.79	5.10	0.00	100.00
Average insurable farm size (ha)	15,130	32.80	61.87	0.26	1,845.54

Note: [1] as a percentage of total eligible area.
Source: own calculations based on NAIK AKI and IACS data



Source: own calculations based on NAIK AKI data

Figure 2. The spatial patterns of subsidised crop insurance levels in Hungary in (a) 2012 and (b) 2016

Table 3. Dynamic spatial-autoregressive model

Variable	All types	'A' type	'B' type	'C' type
Lagged subsidised insurance level (%)	0.4584***	0.4480***	0.3867***	0.2642***
	(0.0163)	(0.0392)	(0.0170)	(0.0190)
Share of fruit crop area in the total insurable area (%)	-0.1017**	-0.0112	-0.1102***	-0.0195
	(0.0478)	(0.0198)	(0.0407)	(0.0121)
Share of vegetable crop area in the total insurable area (%)	0.0856**	-0.0245	0.2157***	-0.0017
	(0.0411)	(0.0295)	(0.0717)	(0.0130)
Average insurable farm size (ha)	0.0260*	0.0094	-0.0148	0.0033
	(0.0147)	(0.0098)	(0.0192)	(0.0049)
2014	1.7088***	0.3957**	2.1753***	1.1133***
	(0.3107)	(0.1679)	(0.3406)	(0.1158)
2015	1.4774***	1.3222***	1.4513***	0.8467***
	(0.3085)	(0.1906)	(0.3393)	(0.1157)
2016	3.5897***	1.5640***	3.4813***	1.9119***
	(0.3825)	(0.2001)	(0.4178)	(0.1471)
Spatial ρ	0.1269***	0.0764***	0.1146***	0.1191***
	(0.0153)	(0.0165)	(0.0165)	(0.0181)
R2 within	0.1238	0.0326	0.0831	0.0234
R2 between	0.8811	0.8550	0.8197	0.6773
R2 overall	0.5480	0.4147	0.4344	0.2248
N	12,104	11,872	10,004	12,104

Standard errors are shown in parentheses.
* P<0.05, ** P<0.01, *** P<0.001. Source: own calculations based on NAIK AKI and IACS data

In the SAR model for all types of subsidised insurance taken together, all the variables are statistically significant. The lagged subsidised insurance level has a significant and positive effect on insurance take-up. The fruit crop area has a significantly negative coefficient, meaning that the average level of insurance cover is lower in settlements with a higher share of fruit production in the total insurable area. The average farm size also has a statistically significant, positive effect on the average level of insurance cover.

The lagged subsidised insurance levels are also positive and statistically significant in the models of the 'A', 'B' and 'C' type insurances. The effect of the shares of fruit and vegetable crop areas in the total insurable area is statistically significant only in the model of the 'B' type insurance, and the signs are the same as for the 'all types' model. The effect of the average farm size is statistically insignificant for the 'A', 'B' and 'C' models. The years 2014-2016 also have a statistically significant and positive effect on insurance usage compared to 2013.

The spatial ρ indicates positive and significant spatial relationship for the combined case and for each type of insurance separately. This result is consistent with the Moran's *I* statistics. The ρ coefficient is the lowest for the all-risk ('A' type) insurance, which is in line with the decreasing Moran's *I* index.

The large differences between the within and between R2 statistics show that the results explain rather the cross section part of the model than the time series part. This can be explained by the relatively stable variables such as share of fruit crops and vegetable crops. For 'all types', 'A' and 'B' insurances, the between R2 statistics are over

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0.8, showing that the models can account for a large proportion of variation over space in insurance usage.

DISCUSSION

The results show that there is a spatial relationship among the insurance decisions of Hungarian crop producers. The rapid increase in the take-up of subsidised insurance between 2012 and 2016 fostered by market growth and the expense of non- subsidised insurance (Kemeny et al., 2014) was not uniform across the country. The biggest increase in the insurance level occurred in western Hungary. Here, the share of fruit crop area in the total insurable area is lower than in other parts of the country, and the average farm size is bigger. In addition to the crop production structure and farm size, farmers' insurance decisions were also influenced by the behaviour of their neighbours and their use of insurance in the previous year. Thus, the results provide support for hypotheses H1 and H2, namely that, for all types of subsidised insurance taken together, farmers' insurance decisions are influenced by those of their neighbours and the production structure of the farm. But only H1 is confirmed for each type of insurance separately. Any significant evidence was not found to support H2 for all-risk ('A' type) and 'C' type insurances.

The Moran's *I* statistic confirmed the spatial relationship among the levels of total insurance and each type of insurance, therefore Tobler's First Law of Geography applies to the spread of subsidised crop insurance in Hungary. But there are different trends by type of insurance. The Moran's *I* statistic increased for total insurance, 'B' and 'C' type insurance, and decreased for 'A' type insurance. The reason for the decreasing Moran's *I* statistic for the latter is that 'A' type insurance levels in the settlements were fairly low across the country in 2012. The increase between 2012 and 2016 was not uniform. By 2016 some settlements had high levels of insurance sporadically resulting lower Moran's *I* statistic. It is anticipated that in the coming years the level of 'A' type insurance will also increase in the nearby settlements. By contrast, the insurance level of the total insurance, 'B' and 'C' type insurance were relatively high for some settlements located sporadically in 2012. The increase of insurance level nearby these settlements cause the increase of Moran's *I* statistic by 2016.

The result, namely the existence of spatial relationship in insurance decision is in line with the findings of Adhikari et al. (2010) for U.S. maize producers. They suggested that if a farmer has yield insurance, but sees that many nearby farmers are using revenue insurance, he or she may switch to the more popular option. This theory may also apply to insured versus non-insured farmers. Settlements with high levels of crop insurance may induce more intensive insurance use in nearby settlements.

Another reason for the similar behaviour among neighbouring farmers can be that slowly-emerging weather risks such as drought are spatially correlated (Odening and Shen, 2014), meaning that neighbouring farms can face similar weather risks.

Other factors were also analysed that influence the decision to purchase crop insurance. The first of these is the lagged insurance level. The results from the model support the evidence from official data sets that the farmer's experience from the previous year has a positive influence on their decision to participate in the subsidised insurance scheme. This is important because it means that once a farmer that joins the system they are likely to continue to participate. As with the lagged insurance use, the years' contribution is also positive for total insurance and for each type of insurance. While the lagged insurance use can be considered as an 'individual' (settlement-level) experience, the years' contribution is the general experience of participation in the subsidised insurance system. The years' contribution in the early stage of the subsidised insurance scheme can be partially explained by farmers switching from non-subsidised to subsidised insurance. But at a later stage of this scheme the years' contribution indicates mostly entry by new users of crop insurance.

According to Goodwin (1993), Sherrick et al. (2003) and Enjolras et al. (2011), farm size also has a positive impact on overall crop insurance use in the U.S. and France. The authors found similar evidence of an impact of farm size for total insurance. The larger farms can more easily afford to pay for crop insurance. In addition, the insurance companies focus on larger farms for businesses reasons.

The production structure (i.e. arable v. fruit v. vegetable crops) is also a determining factor, but evidence was found for this only for total insurance and 'B' type insurance (Table 3). The reason of insignificance of production structure in case of 'A' type is that the all-risk insurance is not available for most fruit crops and vegetables and the non-insurable areas were not taken into consideration in the analysis. The fruit crop and vegetable producers prefer the 'B' type insurance to 'C' type if it is available for the crop chosen, because the risks covered by 'B' type insurance are sufficient for these producers and the minimal level of risk premium support is at least 40 percent for 'B' type and 30 per cent for 'C' type (the minimum level for 'A' type insurance is 55 per cent). These reasons explain on the one hand the determining role of production structure in case of 'B' type insurance and the insignificance of vegetable and fruit crop level in case of 'C' type insurance.

A high share of fruit production discourages participation in the subsidised insurance system. This can be explained by the typical damage scale. Hail and spring frost can severely damage fruit crops and can cause a high level of financial loss at the farm level, too. In Hungary, high farm-level financial loss entitles farmers to compensation from the damage mitigation scheme. For fruit crops, the farmer's damage mitigation scheme contribution is relatively low compared to arable crops. For small, non-diversified farms with high shares of fruit production, the first scheme is an alternative way to insure. Nevertheless, the damage mitigation scheme compensation does not replace the insurance compensation but complements it.

CONCLUSIONS

The primary purpose of this research was to examine the impacts of spatial relationship and farm structure on the take-up of subsidised crop insurance. Although several studies have previously investigated the factors affecting insurance use, to the best of the authors knowledge, none have examined the spatial relationship of insurance use at settlement level. The empirical results show that settlements with high levels of crop insurance can induce more intensive insurance use in nearby settlements. This finding can help both decision makers and insurance companies to expand the take-up of crop insurance, for example through the improved design of awareness-raising and marketing strategies.

There will be an increasing need for subsidised crop insurance because of the effects of climate change and more frequent extreme weather conditions. The Hungarian subsidised two-scheme risk management system is a unique approach that is designed to expand coverage of both the area of production insured and the range of weather risks beyond what can be achieved only with non-subsidised insurance. The evaluation of the system's performance can therefore provide important insights for the further development of insurance products in other EU Member States. From this analysis, the authors conclude that some improvements to the system are possible.

In particular, since a high share of fruit production discourages participation in the subsidised insurance system, both the damage mitigation scheme and the insurance scheme for fruit production need further refinement.

This study evaluates the spatial and temporal development of subsidizes crop insurance regardless of the risks covered. Further research is needed to investigate the spread of insurance for the weather risks separately, e.g. hail, drought, spring frost. In this case the regional probability of risk incidence also should be considered.

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