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INSIGHTS ON DIVERSIFYING AGRICULTURE SYSTEMIC RISK ACROSS REGIONS – APPROACHING THE ROMANIAN CASE

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Summary: The scope of the research is to reveal several insights on diversifying systemic risk across the eight Romanian development regions for the wheat culture. In order to pursue the scope of paper, the research is threefold and encompasses a series of results as follows: (1) tracking the specialized literature and based on crop yield data, there is developed an area yield index that resembles the payoff of a derivative contract; (2) further, by employing parametric and nonparametric measures, there is quantified the dependence of the payoffs across the eight development regions and (3) the investigation is complemented with cluster analysis for determining natural and statistically significant grouping of the Romanian development regions considering the values of the index. The main findings reflect mostly a low potential of diversifying risk at regional level.

Keywords: agriculture systemic/catastrophe risk, risk management, area yield index

1. Selective research grounds – short insights

There is generally acknowledged that, besides asymmetrical information (Skees and Reed, 1986), systemic risk is one of the most important impediments when establishing a market for private crop insurance (Miranda and Glauber, 1997; Duncan and Myers, 2000; Shen and Odening, 2013). Following these arguments, the specialized literature focused on investigating whether systemic risk stands as an obstacle for crop insurance for specific markets and on developing methods and tools for mitigating this particular risk (Wang and Zhang, 2003; Xu et al., 2010; Okhrin et al., 2013; Shen and Odening, 2013).
Considering the importance of the agriculture sector in Romania, developing risk management tools for this sector could enhance capital allocation, at macro level, and even out the revenues of the SME and big companies, at micro level, while standing as a key component for pursuing corporate competitive advantages at EU level. Therefore, the present paper revolves around investigating the potential of diversifying systemic risk across the eight Romanian development regions for the wheat culture by employing an area yield index.

2. Data and methodology

The base sample considered within this research consists in wheat crop yield data collected from 1990 until 2013 for the eight Romanian Development Regions (North-West – VI, Centre – VII, North-East – I, South-East – II, South-Muntenia – III , Bucharest – Ilfov – VIII, South-West Oltenia – IV, and West – V). Following the specialized literature (Shen and Odening, 2013, 6), for each of these regions, there were determined area yield indices as a deviation of realized area yield from a strike level considered as the wheat long-term average of the area yield. The index resembles the payoff structure of a derivative contract (put option), being computed as a product between: (1) the maximum value between zero and the difference between the strike level actual area yield and (2) the tick value (the average of the annual minimum prices on the Romanian representative markets). In order to account for various

diversification potentials, the strike level was considered as follows: (1) at regional level (for each of the eight regions), at macro-regional level (for each of the four Romanian macro-regions) and at country level (national coverage).
Further, in order to check for the risk diversification potential, the analysis consisted in using dependence measures both through a parametric (Pearson Correlation) and a nonparametric approach (Kendall's tau_b and Spearman Rho) to account for the association of the payoffs across the eight development regions. The examination was consolidated by employing cluster analysis considering the long-term values of the mean and the standard deviation of the index as a proof of the diversification pattern. In order to attain the natural and statistically significant grouping of the Romanian development regions, the hierarchical cluster analysis was applied, considering the Squared Euclidian for distance measure and the Ward's method.

3. Main findings and results

In Table 1, Table 2, and Table 3 there are displayed the results of the association analysis (for space reasons, there are presented the Pearson Correlation and Kendall's tau_b values, while the Spearman Rho values, similar to the former ones, are available at the author, on demand).

Table 1: Dependence analysis – regional approach

Correlation Coefficients	Region	VI	VII	I	II	III	VIII	IV	V
Pearson Correlation	VI	1	,762**	,421*	,151	,146	,192	,256	,879**
Kendall's tau_b		1	,633**	,348*	,295	,248	,325	,309	,826**
Pearson Correlation	VII	,762**	1	,690**	,258	,270	,386	,354	,754**
Kendall's tau_b		,633**	1	,558**	,295	,324	,391*	,507**	,649**
Pearson Correlation	I	,421*	,690**	1	,688**	,725**	,776**	,626**	,439*
Kendall's tau_b		,348*	,558**	1	,436*	,370*	,447*	,524**	,332
Pearson Correlation	II	,151	,258	,688**	1	,908**	,844**	,648**	,136
Kendall's tau_b		,295	,295	,436*	1	,700**	,690**	,558**	,281
Pearson Correlation	III	,146	,270	,725**	,908**	1	,957**	,847**	,094
Kendall's tau_b		,248	,324	,370*	,700**	1	,837**	,538**	,322*
Pearson Correlation	VIII	,192	,386	,776**	,844**	,957**	1	,836**	,147
Kendall's tau_b		,325	,391*	,447*	,690**	,837**	1	,459**	,368*
Pearson Correlation	IV	,256	,354	,626**	,648**	,847**	,836**	1	,284
Kendall's tau_b		,309	,507**	,524**	,558**	,538**	,459**	1	,426*
Pearson Correlation	V	,879**	,754**	,439*	,136	,094	,147	,284	1
Kendall's tau_b		,826**	,649**	,332	,281	,322*	,368*	,426*	1
Correlation is significant at the: ** - 0.01 level (2-tailed).; * - 0.05 level (2-tailed).									

Source: Authors' contribution (developed in SPSS-IBM)

The results for the analysis developed at regional level (see Table 1) reflect that all the dependence measures are positive.
While, as expected, the highest dependence is between the indices for the Bucharest - Ilfov and South Muntenia Regions, the lowest one is between South Muntenia and West Regions. Lower association values (below 0.2) are registered between the following regions: South-Muntenia and North-West, South-East and North-West, South-East and West, Bucharest - Ilfov and North-West, and Bucharest - Ilfov and West.
The results for the research developed at macro-regional level (see Table 2) highlight, however, a different state of facts as there are identified two negative correlation coefficients (through the parametric approach): for the South Muntenia and West Regions and for the Bucharest - Ilfov and West Regions. Though positive, lower association values (below 0.2) are recorded between the following regions: South-East and North-West, South-Muntenia and North-West, South-East and West, and South-West Oltenia and West. The nonparametric measures generally support the Pearson correlation results.

Table 2: Dependence analysis –macro regional approach

Correlation Coefficients	Region	VI	VII	I	II	III	VIII	IV	V
Pearson Correlation	VI	1	,762**	,420*	,149	,144	,209	,313	,630**
Kendall's tau_b		1	,668**	,348*	,295	,248	,325	,432**	,712**
Pearson Correlation	VII	,762**	1	,690**	,258	,270	,396	,413*	,585**
Kendall's tau_b		,668**	1	,539**	,320	,348*	,415*	,575**	,671**
Pearson Correlation	I	,420*	,690**	1	,687**	,724**	,770**	,635**	,367
Kendall's tau_b		,348*	,539**	1	,436*	,370*	,447*	,447**	,467*
Pearson Correlation	II	,149	,258	,687**	1	,909**	,843**	,642**	,106
Kendall's tau_b		,295	,320	,436*	1	,700**	,690**	,580**	,239
Pearson Correlation	III	,144	,270	,724**	,909**	1	,955**	,830**	-,031
Kendall's tau_b		,248	,348*	,370*	,700**		,837**	,571**	,181
Pearson Correlation	VIII	,209	,396	,770**	,843**	,955**	1	,809**	-,022
Kendall's tau_b		,325	,415*	,447*	,690**	,837**	1	,485**	,267
Pearson Correlation	IV	,313	,413*	,635**	,642**	,830**	,809**	1	,181
Kendall's tau_b		,432**	,575**	,447**	,580**	,571**	,485**	1	,398*
Pearson Correlation	V	,630**	,585**	,367	,106	-,031	-,022	,181	1
Kendall's tau_b		,712**	,671**	,467*	,239	,181	,267	,398*	1
Correlation is significant at the: ** - 0.01 level (2-tailed).; * - 0.05 level (2-tailed).									

Source: Authors' contribution (developed in SPSS-IBM)

The country level analysis (see Table 3) stresses a similar situation to the macro-regional one from two perspectives: (1) there are also insulated two negative correlation coefficients for the same pairs of development regions and (2) positive and low association values (below 0.2) are recorded between the same pairs of regions (however, there is also recorded such a value for an additional pair: Bucharest - Ilfov and North-West.

Table 3: Dependence analysis – country approach

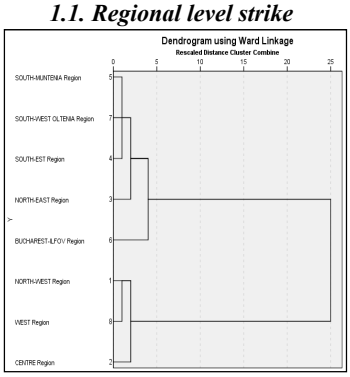
Correlation Coefficients	Region	VI	VII	I	II	III	VIII	IV	V
Pearson Correlation	VI	1	,731**	,391	,162	,059	,117	,251	,616**
Kendall's tau_b		1	,621**	,449**	,324	,272	,345*	,353*	,598**
Pearson Correlation	VII	,731**	1	,718**	,273	,243	,387	,360	,564**
Kendall's tau_b		,621**	1	,540**	,324	,235	,418*	,486**	,567**
Pearson Correlation	I	,391	,718**	1	,684**	,704**	,763**	,612**	,345
Kendall's tau_b		,449**	,540**	1	,450**	,326	,475**	,343*	,290
Pearson Correlation	II	,162	,273	,684**	1	,895**	,832**	,669**	,152
Kendall's tau_b		,324	,324	,450**	1	,710**	,690**	,605**	,327
Pearson Correlation	III	,059	,243	,704**	,895**	1	,956**	,833**	-,046
Kendall's tau_b		,272	,235	,326	,710**	1	,832**	,599**	,198
Pearson Correlation	VIII	,117	,387	,763**	,832**	,956**	1	,819**	-,045
Kendall's tau_b		,345*	,418*	,475**	,690**	,832**	1	,507**	,182
Pearson Correlation	IV	,251	,360	,612**	,669**	,833**	,819**	1	,128
Kendall's tau_b		,353*	,486**	,343*	,605**	,599**	,507**	1	,432*
Pearson Correlation	V	,616**	,564**	,345	,152	-,046	-,045	,128	1
Kendall's tau_b		,598**	,567**	,290	,327	,198	,182	,432*	1
Correlation is significant at the: ** - 0.01 level (2-tailed).; * - 0.05 level (2-tailed).									

Source: Authors' contribution (developed in SPSS-IBM)

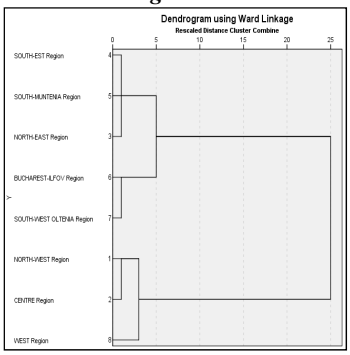
The main findings of the cluster analysis are presented in Figure 1. As displayed in figures 1.1 (regional approach), 1.2 (macro-regional approach), and 1.3 (country approach), according to the average values (mean) and volatility (standard deviation) of the wheat area yield indices, the eight development regions group in two main groups irrespective of the analysis level (a first cluster comprises the following regions: South-East, South-Muntenia , Bucharest – Ilfov, South-West Oltenia, while a second one encompasses: the North-West, Centre, North-East, and, West regions). This clustering pattern supplements the dependence analysis reflecting that systemic risk could be diversified between the western and centre regions, on one side, and the southern and eastern regions on the other.

Figure 1: Area yield index based clusters

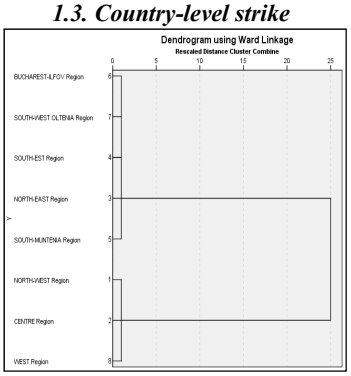
1.1. Regional level strike



1.2. Macro-regional level strike



1.3. Country-level strike



Source: Authors' contribution (developed in SPSS-IBM)

4. Concluding remarks

The association analysis reflects a rather low potential of diversifying risk across the regions for the wheat culture, the correlations being mostly positive. However, when varying the reference strike at macro-regional and country level, there is envisaged a week diversification opportunity which is enforced by the negative correlations between three regions (two from the southern part of the country, and one from the western one). In addition, the cluster analysis enforces the results of the dependence research as, on the long term, the regions are clustered in two groups reflecting a diversification prospective between the southern and eastern regions, on one side, and the western and centre regions, on the other. As further research, there could be considered other cultures as well as other dependence measures.

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