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ANALYSING FOOD SECURITY AT EUROPEAN LEVEL

Abstract. *The population of the planet is constantly growing, the economy is growing very fast, the resources are limited, and the consequences are seen in the degradation of nature, implicitly in the food sector. For this reason, nowadays, more and more emphasis is placed on food security. Food security is defined by physical, social and economic access to sufficient and nutritious food to meet dietary needs for a healthy and active life.*

Previous studies have highlighted the link between food security and climate, social and economic factors. This study examines food security and economic and social factors in Europe in 2016, using cluster analysis and factorial analysis. For this, were analyzed the variables: the cultivated agricultural area, the agricultural unit income per unit of annual work, the number of emigrants, the number of people at risk of poverty and the Food Safety Index. At European level, countries are homogeneous regarding food security, with high scores, existing a link between number of emigrants and cultivated agricultural area, Food Security Index and agricultural sector productivity, and productivity of the agricultural sector and the number of people at risk of poverty.

Keywords*: Food Security, Poverty, Migration, Europe, Main Component Analysis, Cluster Analysis.*

JEL Classification: C38, C43, F22, I39

1. Introduction

The population of the planet is steadily increasing, and this also involves an increase in consumption, implicitly an increase regarding food demand. Increasing demand for food affects their security, so food security is a matter of interest and topicality.

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Food security involves a healthy and active life for the population, having physical, social and economic access to sufficient and nutritious food to meet needs. Food security is influenced by economic, social and climatic factors and has many implications.

There are many studies on food security, the results highlight that climate change is the main factor influencing food security. Therefore, measures have been proposed to adapt to these changes, trying to diminish the negative effects on food security.

Food security has been analysed in correlation with economic factors. The less developed countries registrate small power of purchasing and allow themselves to import less, and this deficit has to be covered by local production. Thus, less developed countries registrate lower food security and measures need to be taken to increase the productivity of the agricultural sector.

Food security has also been studied related with migration and poverty, a country with low food security and high level of poverty is not an attractive destination for those who want to migrate. Migrants will seek better conditions, both economically, and socially.

This article presents the results of a research that aims to establish a relationship between the variables describing food security for Europe in 2016. For this purpose, were analysed the agricultural area cultivated, the income from the agricultural factor per unit of annual work, the number of migrants, the number of people at risk of poverty and Food Safety Indicators.

2. Review of the scientific literature

Competition for water, energy and land has an upward trend and, together with climate change, affects the ability to produce food. The solution is to reduce the impact of the food system on the environment, i.e. to produce more food and to use it more efficiently and equitably, and for this a multilateral and unitary global strategy is needed to ensure sustainable and fair food security (Godfray et al., 2010).

A factor influencing food security is climate change, thus is necessary to adapt it. Although some cultures and regions are inevitably favored regarding climate change, some have required investments in agriculture to adapt to climate change. In order to identify adaptation priorities, a climate risk analysis has been carried out for crops in 12 unsafe food regions. It was based on 20 patterns of general statistical circulation and climate projections for 2030. The results show that without sufficient adaptation measures, the regions will likely suffer negative effects on many crops that are important for large, unsafe human populations (Lobell et al., 2008).

Other studies associate food security with global agricultural production and ocean heating. Less developed countries registrate small power of purchasing and import as little food as possible from global markets, the difference being

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covered by local production. Local agricultural production is determined by the quantity and quality of arable land, the quantity and quality of agricultural inputs (fertilizer, seeds, pesticides, etc.) and policy technology, practices and practices (Funk and Brown, 2009).

Rosegrant and Cline have studied food security and have shown that crop yields have fallen in many areas, with fewer investments in research and infrastructure and rising water scarcity. Other factors that significantly affect food security include climate change and HIV (Rosegrant and Cline, 2003).

Other studies analyze food security in relation to economic factors. McGregor studies the link between environmental change and migration, as well as the link between food security and migration. The study focuses on the means of subsistence for refugees and the economic and ecological transformation in the areas receiving refugees, especially when the reception of displaced populations has benefited on long term from host economies. The nature of interventions for displaced populations is an important factor in influencing food security in hosting areas, and existing practice on refugee assistance may be counterproductive (Gregor, 1994).

Crush (2013) addresses the link between migration and food security based on a study in 11 African cities. The results show different patterns between urban migrant households and non-migrant households, both in terms of food security levels, income sources, food purchasing strategies, and participation in urban agriculture. In conclusion, there is a link between migration and development and food security.

Lacroix studies migration, rural development, poverty and food security. According to the study, migration alone can not support an agricultural development strategy. Remittances are largely used for daily consumption, especially in poor households, and improve household food security. Countries experiencing temporary migration and recruiting low-skilled farmers will benefit in rural areas; in other countries, migrants tend to come from richer urban areas. The conclusion of the study is that migration has limited effects on rural poverty, but it affects food security (Lacroix, 2011).

3. Data and methodology

Food security is described by the Food Safety Index. Studies on food security reveal that is mainly related to the level of poverty and migration. According to the literature, the agricultural potential is a component of food security and this is described by the cultivated agricultural area and the productivity of the agricultural sector.

An economy that has large cultivated agricultural area and large productivity in the agricultural sector is a high-security food economy. High food security should involve low poverty and migration.

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For this, food security for 2016 was analyzed across Europe, and the variables used are: cultivated agricultural area, farm income per unit of annual work, number of emigrants, number of people at risk of poverty and Food Safety Index. The data source is the Eurostat website, http://ec.europa.eu/eurostat and the Global Food Security Index, https://foodsecurityindex.eiu.com/.

As defined in the 1996 World Food Summit, food security is the state in which people have always physical, social and economic access to sufficient and nutritious food to meet their dietary needs for a healthy and active life. Food Security Index reflects a country's food security level. It analyses the essential aspects of accessibility, availability and quality using a set of 113 countries. This is a dynamic quantitative and qualitative assessment model built of 28 unique indicators that measure these food security factors and ranges from 1 to 100.

Agricultural unit income per unit of annual activity measures agricultural productivity. Factor input corresponds to real (net) value added to the cost of agricultural factors, using the GDP price index as the deflator. Annual work units are defined as full-time equivalent jobs (corresponding to the number of full-time equivalent jobs), i.e. the total number of worked hours, divided by the average annual number of hours worked in full-time jobs on the economic territory.

People at risk of poverty or social exclusion are the total of those who: are at risk of poverty after social transfers, are considerably deprived of material resources or live in households with low work intensity. Individuals are considered to be at risk of poverty considering social transfers if they have an equivalent disposable income below the poverty risk threshold, which is set at 60% of the nationally equally disbursed disposable income. Materially disadvantaged persons have severe living conditions constrained by lack of resources and can not afford i) to pay rent or utilities bills, ii) to maintain adequate heat, iii) a washing machine, iv) a color TV, or v) a telephone. People living in low-intensity households are those aged between 0 and 59 living in households where adults (aged 18-59) work in the last year with 20% or less of their total work potential.

The agricultural area used describes the area used for agriculture and includes: arable land; permanent pastures; permanent crops, gardens. The term does not include unused agricultural land, forests and land occupied by buildings, farms, rails, ponds, etc.

The number of emigrants is the total number of emigrants for each country in Europe.

An economy with large cultivated agricultural area and large productivity in the agricultural sector is an economy with high-security food. High food security should involve low poverty and migration.

The first hypothesis to be tested is that there is a link between food security and the analysed variables in Europe. An increase on food security implies an increase on agricultural productivity and agricultural area, and a decrease on number of people at risk of poverty and emigrants.

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The second hypothesis to be tested is that countries are different according to the geographical area. Countries are expected to be homogeneous within a geographical area and heterogeneous between areas.

For testing the hypothesis in the analysis are used: cluster analysis and analysis of the main components.

Cluster analysis involves detecting object partitioning, i.e. grouping observations that are similar in homogeneous subsets that can reveal patterns related to the phenomenon studied. To evaluate whether there is a similarity between objects, a remote function and a wide variety of grouping algorithms based on different concepts are used. Similarity measures are first calculated between observations and between clusters once the observations begin to be grouped into clusters (Boccard and Rudaz, 2013).

The hierarchical cluster analysis produces a unique set of categories or clusters by sequentially grouping the variables, clusters, or variables and clusters. Once the correlation matrix is formed, possible pairs of variables and clusters are attempted at each stage, and that pair producing the highest average intercollation in the test group is chosen as the new group. Unlike other cluster analysis that form a single set of clusters exclusively mutually and exhaustively, this technique proceeds successively from clusters closer and less inclusive through more comprehensive clusters and continues until all variables are clustered in a single group (Bridges, 1966).

The hierarchical grouping algorithm is based on the correlation method of Sokal and Michener, which was developed for group correlation matrices (Sokal and Michener, 1958). The objective of this algorithm is the dendrogram that assembles all elements into a single tree. For a data set n is calculated a matrix of similarity, which contains similarity scores for all data pairs. The matrix identifies the highest value that represents the most similar data pair.

A node is created that joins these two data and calculates a node expression profile by averaging the integrated elements (missing values are skipped and the two merged elements are weighted by the number of data they contain). The matrix of similarity is updated with this new node that replaces the two joined elements, and the process is repeated n-1 times until only one element remains (Eisen et al., 1998).

The hierarchical grouping algorithm is one of the oldest and most commonly used cluster analysis methods. It starts from all the initial data, and through successive mergers of units it reaches a single group. Thus, they fall into the following scheme:

Initialization

$P_N = \{C_1, C_2 \ldots\ldots C_N\}$;

$C_j = \{O_j\}$ $j = 1,2 \ldots\ldots N$;

$k = 1$;

The current stage:

When $N-k > 1$

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is selected C_i, $C_j \in P_{N-k+1}$ using a local criterion;
$C_{N+k} = C_i \cup C_j$;
$P_{N-k} = (P_{N-k-1} \cup \{C_{N+k}\}) | \{C_i, C_i\}$
k = k+l
End.

The local criterion is the one that only uses the information in D and the current partition. Thus, the algorithm does not use any memory on how this partition has been reached or on the features of partitions other than the next one. (Hansen and Jaumard, 1997).

The division values for all subsets of entities in O, and thus for all O partitions, belong to the set of difference values associated with MST margins (Rosenstiehl, 1967).

Principal Component Analysis (ACP) is a multidimensional analysis method that applies to the study of centered and reduced numeric variables. ACP is a method of factorial analysis that reduces a complex system of variables correlated with a small number of latent variables (Pintilescu, 2007).

The principle of this method is to extract the smallest number of components that reflects as much as possible the total information contained in the original data, the components being constructed so that they are uncorrelated, each of these new variables being a linear combination of original variables. (Giannelloni and Vernette, 2001)

The objectives of an analysis of the main components are (Baccini, 2005):

• the "optimal" graphical representation of individuals, minimizing the deformation of the cloud of points in a sub-space Eq of dimensions q (q < p);

• graphical representation of variables in a subset Fq, best explaining the initial linkages between these variables;

• the reduction of the size, i.e. the approximation of the table X by a table q (q < p).

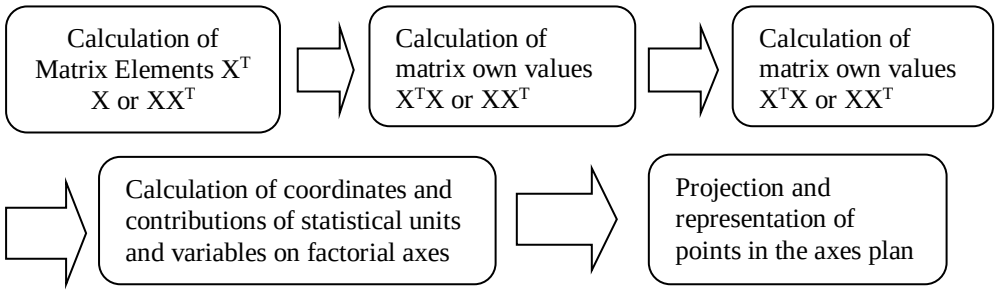

Figure 1. Stages of main component analysis
Source: Pintilescu, 2003, p. 37

Using the analysis of the main components, the number of factorial axes is chosen according to the following criteria:

DOI: 10.24818/18423264/54.4.20.11

• Kaiser's criterion. This criterion implies choosing the number of axes for which the values of one's own correspond to a value greater than one. (Saporta and Ștefănescu, 1996);

• Evrard's criterion. This critique is based on the graphical representation of own values and follows the sudden drops of inertia explained by them;

• Benzecri's criterion. This criterion involves choosing the number of axes that explains more than 70% of the total cloud point variation;

• parallel analysis method. This analysis is applicable to standardized data and involves generation of random samples, and the variables characterizing population are assumed to be uncorrelated two by two. (Saporta and Ştefănescu, 1996);

• the regression method. This is similar to parallel analysis, but does not involve the generation of random samples (Gabor et al., 2010).

4. Results and discussion

In 2016, in Europe Food Security Index records a minimum of 59.4 and a maximum of 89.7. These values show that in Europe the values are higher than the middle of the scale, i.e. the level of food security is medium and high. The map of food security index is shown in Figure 2.

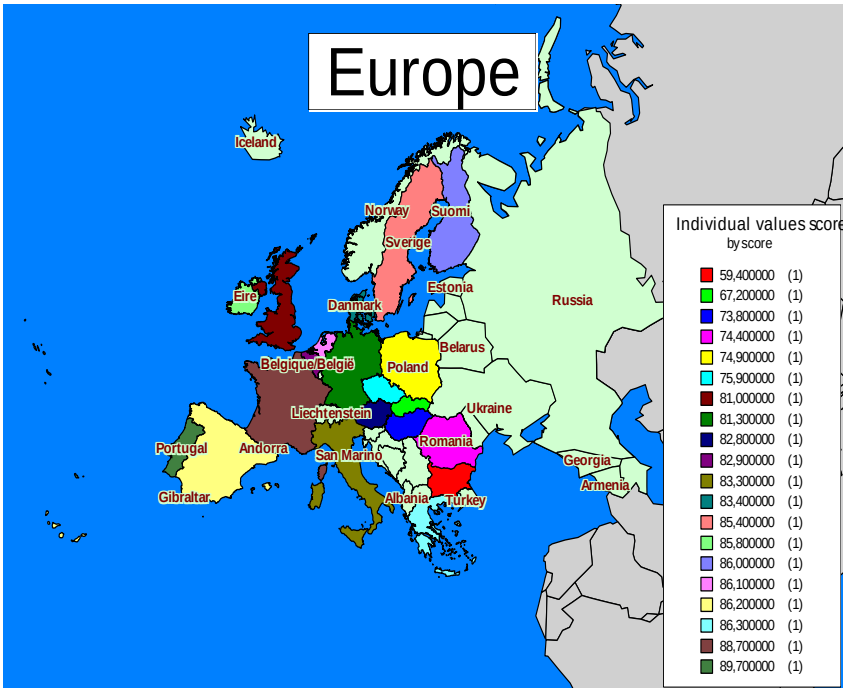

Figure 2. Map of the Food Security Index, 2016

Source: Data analysis was developed by authors using the SPSS software

DOI: 10.24818/18423264/54.4.20.11

Regarding Food Safety Index, the countries of Europe are grouped in 3 clusters. The first cluster contains: Belgium, Denmark, Germany, Ireland, Greece, Spain, France, Italy, the Netherlands, Austria, Portugal, Finland, Sweden and the United Kingdom. The second cluster includes: Czech Republic, Hungary, Poland, Romania, Slovakia. Bulgaria forms itself a cluster, registering different values from all other countries.

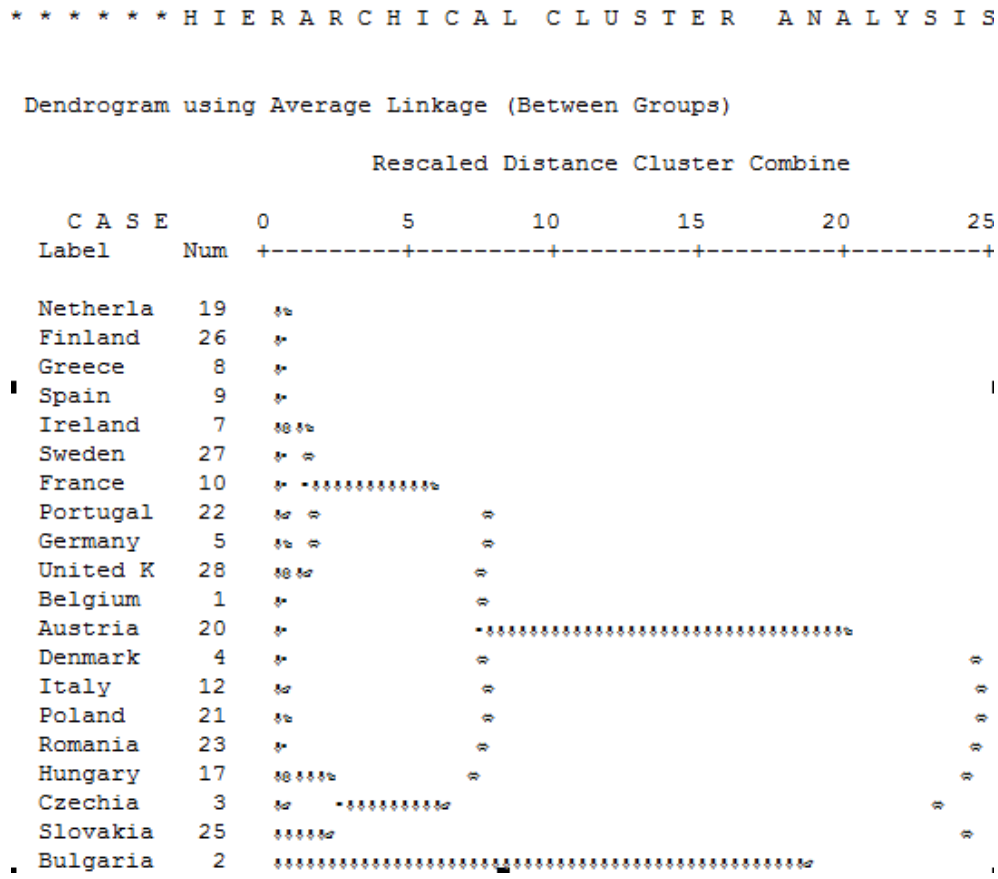

Figure 3. Dendogram

Source: Data analysis was developed by authors using the SPSS software

According to studies, Food Safety Index is correlated with cultivated agricultural area, agricultural sector productivity, degree of poverty and number of emigrants. In Europe for 2016, the direction and intensity of correlations are presented in the correlation matrix (Table 1).

DOI: 10.24818/18423264/54.4.20.11

Table 1. Correlation Matrix

Correlations

		AFI	area	poverty	emigrants	score
AFI	Pearson Correlation	1	,299	-,498**	,407*	,512*
	Sig. (2-tailed)		,122	,007	,032	,021
	N	28	28	28	28	20
area	Pearson Correlation	,299	1	,115	,859**	,160
	Sig. (2-tailed)	,122		,562	,000	,501
	N	28	28	28	28	20
poverty	Pearson Correlation	-,498**	,115	1	,017	-,332
	Sig. (2-tailed)	,007	,562		,930	,152
	N	28	28	28	28	20
emigrants	Pearson Correlation	,407*	,859**	,017	1	,186
	Sig. (2-tailed)	,032	,000	,930		,431
	N	28	28	28	28	20
score	Pearson Correlation	,512*	,160	-,332	,186	1
	Sig. (2-tailed)	,021	,501	,152	,431	
	N	20	20	20	20	20

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Source: Data analysis was developed by authors using the SPSS software

The strongest link is between number of emigrants and cultivated agricultural area, the correlation coefficient being 0.859, and the link is direct. This means that the number of emigrants in Europe in 2016 increased when the cultivated agricultural area increased. These increases reflect that those who emigrate are qualified people who do not work in the agricultural field. Another explanation could be the low productivity of the agricultural sector or cultivation of non-food products. Between Food Security Index and agricultural sector productivity there is an medium and direct link, when the productivity of the agricultural sector increases, the food safety index also increases, too. The link between productivity of the agricultural sector and number of people at risk of poverty is medium, but inverse, when the productivity of the agricultural sector increases, the number of people at risk of poverty decreases.

Table 2. Explained Variance

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2,151	43,015	43,015	2,151	43,015	43,015
2	1,702	34,044	77,060	1,702	34,044	77,060
3	,618	12,368	89,428			
4	,374	7,482	96,910			
5	,155	3,090	100,000			

Extraction Method: Principal Component Analysis.

Source: Data analysis was developed by authors using the SPSS software

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According to factorial analysis, 77.06% of the variance of the analysed variables is explained by the first two factorial axes (Table 2). From the graphical representation, it can be noticed that the used variables: agricultural area, number of emigrants, Food Security Index and productivity of the agricultural sector are explained by the first factorial axis, registrating a direct link. The second factorial axis explains the variation of the variable, the number of people at risk of poverty, the link with the rest of the variables being inverse.

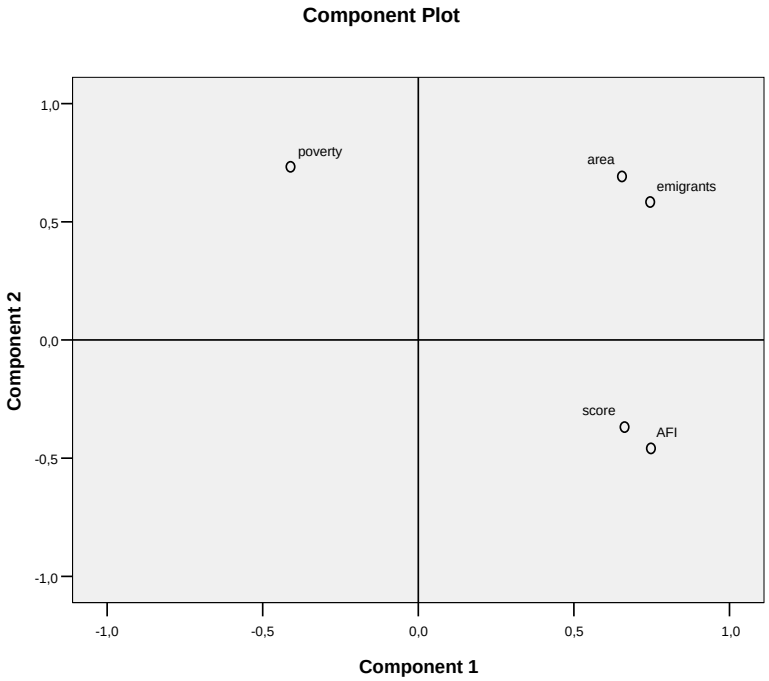

Figure 4. Representation of the variable in the first two factorial axes
Source: Data analysis was developed by authors using the SPSS software

Graphic representation of countries shows that the countries with biggest cultivated agricultural areas are: Spain, France, Germany, United Kingdom, and at the opposite pole, the poorest countries regarding cultivated agricultural areas are Romania and Bulgaria. Countries with a high score on high food security and agricultural productivity are: the Netherlands, Belgium and Spain.

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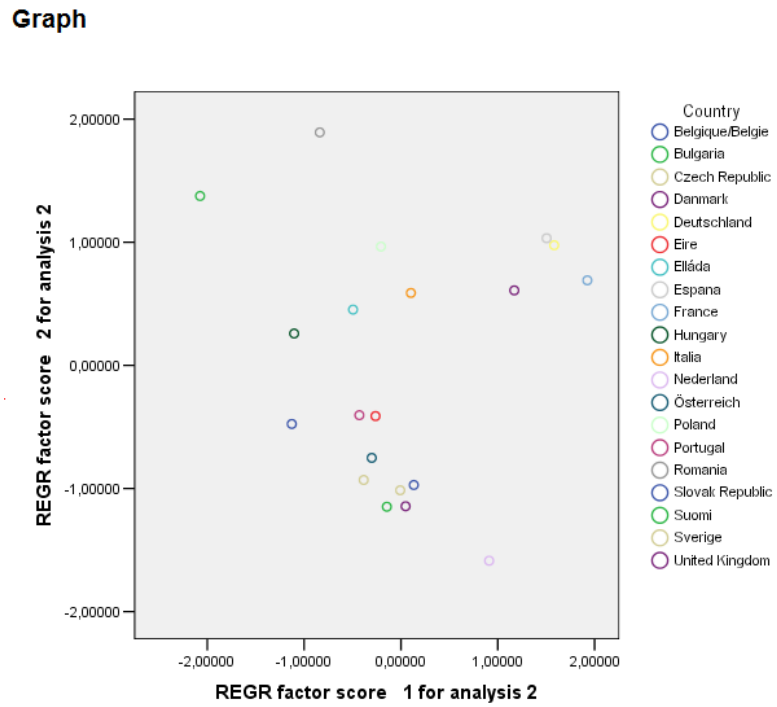

Figure 5. Representation of countries in the first two factorial axes
Source: Data analysis was developed by authors using the SPSS software

5. Conclusions

Food security implies access to healthy and sufficient food. Population and economy are registrating a growing trend, and resources are limited, exists an uncertainty regarding food security.

Food security is influenced by climatic conditions, so that the productivity of the agricultural sector differs from one region to another. Regions have different conditions for agriculture and some are forced to import. Import is conditioned by living/poverty and purchasing power. All these have implications for the migration phenomenon, the migrant population is looking for better living conditions from all perspectives.

According to studies, food security is linked to cultivated agricultural area, agricultural productivity, poverty and number of emigrants. According to this, we analysed cultivated agricultural area, farm income per unit of annual work, number of emigrants, number of people at risk of poverty and Food Safety Index in Europe in 2016.

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An economy that has big cultivated agricultural area and productivity in agricultural sector is a high-security food economy. High food security should involve low poverty and migration.

Following the study, the strongest link is between number of emigrants and cultivated agricultural area, the correlation coefficient being 0.859, and the link is direct. This means that the number of emigrants in Europe in 2016 increased when the cultivated agricultural area increased. These increases reflect that those who emigrate are qualified people who do not work in agricultural sector. Another explanation could be the low productivity of the agricultural sector or cultivation of non-food products. Between Food Security Index and agricultural sector productivity there is a medium and direct link, when the productivity of agricultural sector increases, the food safety index also increases. The link between the productivity of the agricultural sector and the number of people at risk of poverty is medium, but inverse, when the productivity of the agricultural sector increases, the number of people at risk of poverty decreases.

Countries with the biggest cultivated agricultural areas are: Spain, France, Germany, United Kingdom, and Romania and Bulgaria are the poorest countries regarding cultivated agricultural. Countries with a high score on high food security and agricultural productivity are: the Netherlands, Belgium and Spain. At European level, countries are not very different regarding food security, with scores higher than half of the scale, and homogeneous according to geographic areas.

Further research aims to extend the sample globally, but also to include other variables. In addition, depending on the possibilities of accessing the specific data series, the study can also be applied at the level of the Romanian regions.

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