

AN ANALYSIS OF AGRICULTURAL DEVELOPMENT AND EMIGRATION IN ROMANIA USING THE SELF ORGANIZING MAPS

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Abstract

Galluzzo, N., 2017. An analysis of agricultural development and emigration in Romania using the Self Organizing Maps. *Bulg. J. Agric. Sci.*, 23 (4): 526–533

In Romania, from the 1990s to the early 2000s, there has been a significant phenomenon of rural emigration from the countryside with a worsening of socio-economic conditions in agricultural areas and rural territories. Most of Romanian farms are below a specific economic threshold proposed by the European Commission in 1985. Causes of these poor levels of farmer's income are attributable to limited agricultural areas that are not efficient in improving investments and technical efficiency. By a quantitative methodology, the purpose of this research was to assess, from 2000 to 2013, in rural areas of Romania, the impact of agrarian and rural development policies, Gross Domestic Product and Agrarian Domestic Product on the emigration throughout Kohonen's maps or Self-Organizing Maps (SOMs). Findings in Kohonen's maps analysis have highlighted a direct relationship between the variables Agrarian Domestic Product and emigration, underlining the positive role of European Union funds disbursed by the second pillar of the Common Agricultural Policy and by the SAPARD in halting partially the emigration from the countryside.

Key words: Kohonen's maps; rural development; emigration; rural areas; Common Agricultural Policy

Introduction

In Romania, after the fall of the Berlin's Wall and the end of a centralized and planned agricultural economy, there was a significant phenomenon of emigration mainly from rural areas and from economically depressed north-east regions near to the border of Moldavia and in rural and agrarian territories close to Bulgaria. The intense emigration in the agricultural territories continued uninterrupted until the early 2000s worsening socio-economic conditions in the rural area towards which the European Union both in the pre-accession phase and also by the Common Agricultural Policy sought to halt throughout specific funds and actions aimed at reducing the rural marginalization in new comer member states (Galluzzo, 2015; 2016a; 2016b). In fact, by the Special Accession Programme for Agricultural and Rural Development (SAPARD) the European Union has financed in Central and

Eastern Europe actions with the purpose of improving the productive fabric in farms and agrarian enterprises in a perspective of structural adjustment. Since 2007, the SAPARD programme has been replaced by the Instrument for Pre-Accession Assistance (IPA) with a financial budget of 11.5 billion euro during the time 2007-2013 (European Union, 2017).

According to the findings and statistical results published by the European Commission and by Eurostat, in Romania, during the period 2005-2013, there was a fall in active farms; in particular, this decrease has involved small holding family farms, managed by elderly entrepreneurs which owned poor plots of land. However, comparing Romanian countryside to other European countries such as Italy, outcomes have highlighted as one third of active farms are concentrated in Romania and Italy (Festuccia, 2013). According to this latter author, more than 90% of agricultural holdings in Romania

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have an utilized area under 5 hectares, with a significant drop in the recent years of agricultural workforce with the downside effect of fostering the out emigration from the countryside in Romanian and in other European nations (Galluzzo, 2016a; 2016b).

The most recent statistical data published by Eurostat and by the Romanian Statistical Institute have shown that the agricultural entrepreneurial fabric is made by 3 629 660 enterprises and more than 90% of them are small family units of production scattered in rural areas. However, the modest dimensions of farms in terms of land capital have had significant consequences on their technical and allocative efficiency, with direct and significant impacts on the emigration from rural areas, generating also a worrying rural exodus, typical of other rural and agrarian European contexts, which, crystallizing, is becoming a structural problem of the European agriculture (Lund and Hill, 1979; Alvarez and Arias, 2004; Galluzzo, 2013; 2015).

The modest plot of land in lots of Romanian farms has not allowed a process of investment both in business growth and also in land fragmentation reduction, in land capital and in innovative technologies aimed at reducing costs and working hours (Burja and Burja, 2010; Galluzzo, 2013; 2016a). According to these latter authors, it is irreplaceable and pivotal the role of the European Union in supporting by specific financial subsidies a strengthening of the socio-economic conditions in Romanian farms and in rural areas particularly in some of them located in less favoured territories.

Since the mid-2000s, in Romania and in all other European countries as well, there has been a significant decrease in the financial budget allocated by the European Union throughout the Community Agricultural Policy with the effect of increasing socio-economic inequalities among various nations (Galluzzo, 2016a; 2016b). Reasons of this rise of dichotomies both among nations and also between each State, also in an agricultural point of view, is attributable to a different size of farms that impacts on socio-economic aspects and on the developmental of rural areas. In Europe, the most depressed rural areas with poor land capital endowments have undergone major migratory processes, both in terms of permanent and also as internal emigration, demonstrating how the agricultural area is a key variable in influencing and slowing down the emigration from rural and agrarian areas, which is significantly affected by financial supports disbursed by the European Union (Cionga et al., 2008).

In order to compare and investigate in the medium term the profitability and socio-economic sustainability of farms, the European Union has established and defined the European Size Unit (ESU). This parameter has been de-

finied by the European Commission Decision 377/1985. Farms below the threshold of 1 ESU are classified as subsistence farms. Assessing statistical data, more than 70% of Romanian farms are classified in this cluster because of their average cultivated area which is less than one hectare (Giurca, 2008). All this explains how the Romanian government, later than the pre-accession phase supported by the SAPARD, has set up in its own National Rural Development Plan 2007-2013 and in 2014-2020, financial resources addressed in making small family farms more competitive and efficient. The purpose of these actions has been focused in stimulating the diversification in agrarian enterprises through the second pillar of the CAP dedicated to the rural development and the socio-economic protection of marginalized rural areas by agritourism, rural tourism and other traditional activities deeply rooted and with a nexus to agricultural and rural traditions. This latter aspect is particularly important investigating in depth occurred changes in Romanian rural socio-economic fabric. In Romania, there has been a significant increase in farms led by young entrepreneurs, characterized by an higher level of professional skills, able to improve the level of profitability and technical and economic efficiency of farms (Tudor and Alexandri, 2015; Galluzzo, 2016a; 2016b). This demonstrates how intangible investments in technology and training have had positive consequences on the ability in making Romanian farms more competitive and economically sustainable in a socio-economic point of view (Lockheed et al., 1980; Tudor and Alexandri, 2015) by slowing down the rural out emigration.

Aim of the research

The purpose of this research was to assess by a quantitative approach the impact of rural and agricultural development policies, financed through the Community Agricultural Policy (CAP) in the second pillar of the CAP and by the SAPARD programme, on the emigration phenomenon and in improving the level of income in all Romanian regions of Romania since 2000 to 2013. Hence, by comparing two seven-year period of time, 2000-2006 and 2007-2013, it has been possible to assess the impact of the policy in favor rural areas in halting the rural emigration before (2000-2006) and after (2007-2013) the enlargement of the EU.

Methodology

In this research one has used a quantitative approach based on the Kohonen's maps or Self-Organizing Maps (SOM) as proposed by Kohonen (Kohonen, 1984; 1995), using Orange Canvas 2.7 software to estimate parameters.

The main correlations in the Self-Organizing Maps have been estimated considering two coupled variables before and after the accession of Romania in the European Union such as: emigration, Gross Domestic Product (GDP), financial subsidies allocated by the SAPARD programme and by the second pillar of the Common Agricultural Policy, ratio of unemployment and ratio of people at risk of poverty, unemployed people and Agrarian Domestic Product.

The maps of Kohonen are particularly useful in estimating the structure and evolution of lots of variables such as poverty, lifestyle, health status, rural development, economic growth and welfare features in different countries in order to obtain a single useful parameter able to compare diachronically clusters of states pointing out remarkable similarities or differences as argued and backing up with other quantitative methods such as the principal components analysis (PCA) assessing by a unique winner neuron (black hexagon) the main relationships among all investigated variables (Kohonen, 2001; Kaski and Kohonen, 1996; Mehmood et al., 2011; Galluzzo, 2016c). In the Self-Organizing Maps the best neuron or unique winner neuron is the black hexagon and the others neurons close to the winner one are characterised by different scale of grey (Mehmood et al., 2011). White hexagons describe in the SOMs neurons which are far away from the winner neuron (Kohonen, 2001).

In this paper, it has used an unsupervised learning process in a limited sized space provided that the topological properties of an input space come from the outside (Kohonen, 2001). The SOM is a neural network where each artificial output neuron is arranged in grids based on a lower dimension in connection to all neurons of input (Haykin, 1994; Haykin and Lippmann, 1994). According to Lucchini 2007, each input or stimulus is in connection to other neurons in the output by a weight vector able to define the position of a centroid in the space. The formula used to update weights of a neuron is W_v (Lucchini, 2007):

$$W_v(t+1) = W_v(t) + \alpha \Theta(v, t) [D(t) - w_v(t)]$$

In the above-mentioned formula $\alpha(t)$ is a decreasing monotone function of the learning coefficient and $D(t)$ is the input vector. The function that defines the Θ area (v, t)

depends on the distance in the lattice between the BMU or optimal unit and the neuron v . In a simplified form, the value equal to 1 is typical of all neurons near the optimal BMU unit otherwise 0 for the others (Kohonen, 1984; Kaski and Kohonen, 1996). Therefore, the winning neuron, as in a Gaussian function, is in a central position and the losing neurons are far away from it which originates a function similar to a bell function. Summing up, the system of interactions is made by some neurons near to the winner which are excited and other neurons, more distant from the winner neuron, are inhibited generating a function similar to a Mexican hat (Kohonen, 1984). The network in the SOM is characterized by a pattern made by two layers; one layer is made up by input and the other layer or Kohonen's layer is constituted by output (Kohonen, 2001). Neurons of the two layers are completely connected to each other, while neurons of the output layer are linked to different output neurons (Kohonen, 1984; Meraviglia, 2001). In the layer of output neurons there is a unique winner neuron which takes all which in the map is the black hexagon.

Results and Discussion

Since 2005 to 2013, findings of Eurostat dataset showed in Romania a drastic drop of more 600 000 agrarian enterprises (Table 1); furthermore, more than half a million farms are characterized by an agricultural area lower than 4 hectares which is used predominately for the self-consumption with few livestock and agrarian commodities produced in farms (Table 1).

Immediately after the fall of Nicolae Ceaușescu's regime in 1989, there was a significant phenomenon of exodus of the population in particular from agricultural and rural territories. The regions of North-West, West and Bucharest-Ilfov have had emigration rates above 15% during the time 1990-2015. Focusing the attention on internal migration flows, rural areas have been significantly affected by a significant emigration towards urban areas which have been considered more suitable to offer better socio-economic conditions than the rural space.

Table 1
Main characteristics of Romanian farms

Year	Farm (n°)	Utilised agricultural area (ha)	Annual working unit (n°)	Livestock unit (n°)	Farms with livestock (n°)
2005	4 256 150	13 906 700	2 595 590	6 602 750	3 453 010
2007	3 931 350	13 753 050	2 205 280	6 041 720	3 333 490
2010	3 859 040	13 306 130	1 610 260	5 444 180	2 836 640
2013	3 629 660	13 055 850	1 552 630	4 975 310	2 727 720

Source: Eurostat

Comparing the emigration in different Romanian counties in 1990 and 2015, there has been an increase in counties that have suffered this phenomenon in recent years; even though, in 2015, the areas close to the border with Moldavia and Hungary to the north and Bulgaria to the south have had the highest level of permanent emigration (Figure 1). In the poorest provinces of Romania characterized by high emigration rates, there was an inverse correlation between levels of wealth, expressed in terms of Gross Domestic Product, and emigration. The quantitative analysis of data between the variables Domestic Product obtained in agriculture and emigration showed significant fluctuations since 2001 to 2015; in fact, in 2001 this value was equal to -0.18 , in 2007 it was -0.08 , in 2013 it was close to -0.32 and in 2015 it was close to -0.2 ; therefore, in the rural and agrarian areas of Romania characterized by low levels of wealth produced by the primary sector, there has been an increase in emigration flows.

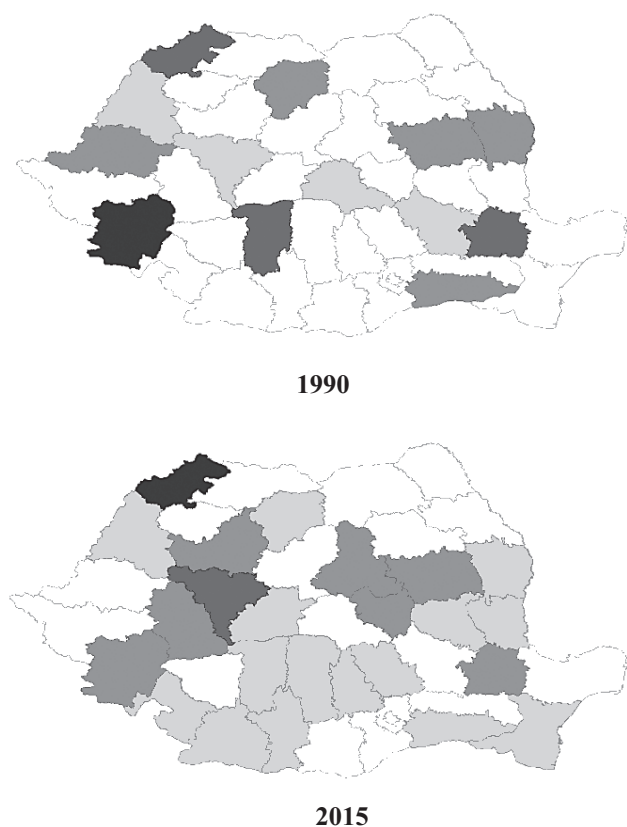


Fig. 1. Permanent emigration in Romanian counties in 1990 and in 2015 in grey scale. Black counties are characterized by the highest level of emigration

Source: our elaboration on data
<http://statistici.insse.ro/shop/?lang=en>

Considering the development paths in the all 8 Romanian regions, it emerged that the economic variables, such as Gross Domestic Product, Agricultural Domestic Products and unemployed people, were pivotal and prevalent in influencing the emigration. This seems particularly true in the counties located in the North-East region where have been pointed out the highest level of permanent emigration. The worst value of socio-economic development has been found in the South-West of Muntenia, region bordering to the Bulgaria, with an high rate of emigration, an high unemployment percentage and low levels of GDP and Domestic Products in the primary sector (Figure 2).

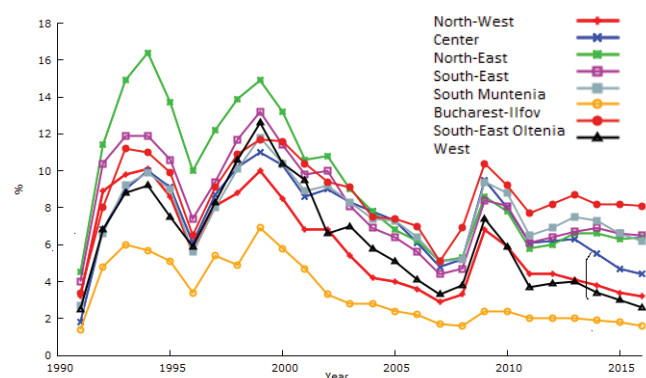


Fig. 2. Evolution of the unemployment rate in different Romanian regions

Source: our elaboration on data Romanian National Institute of Statistics on the website <http://statistici.insse.ro/shop/?lang=en>

Romanian counties located in the North-East, South-East and South Muntenia regions have been characterized by values, in percentages of poverty risk, slightly below 50% and they have not pointed out over the years any significant decrease compared to the average national value (Table 2); in the region of Bucharest-Ilfov the population at risk of poverty in 2015 is decreased by 44% compared to the value assessed in 2007. In general, areas characterized by an intense depopulation process, high unemployment rates and wealth levels, in terms of GDP, much lower than the other values assessed in other Romanian regions have had a higher risk of poverty.

The analysis with the Kohonen's maps have pointed out as over the time 2000-2006 and 2007-2014, comparing before and after the accession of the Romania into the European Union, Romanian regions with higher level of emigration from the countryside have had the higher level of Gross Domestic Product (Figure 3). All this has corroborated the hypothesis of a heterogeneous distribution of wealth among regions and within each region among people, with consequential negative effects on the emigration; hence, findings have demonstrated if the wealth, in terms of GDP, is not fair-

Table 2
Romanian population at risk of poverty in percentage over different years

Region	Years									
	2007	2008	2009	2010	2011	2012	2013	2014	2015	
North-West	39.2	34.9	36.2	32.1	35.2	33.5	32.3	32.1	28.0	
Center	39.5	39.0	33.3	31.3	30.6	34.3	36.0	35.7	31.6	
North-East	56.7	55.5	52.9	52.4	51.7	52.1	51.5	49.4	46.2	
South-East	52.9	46.7	42.6	51.7	49.6	54.1	53.9	53.2	46.1	
South-Muntenia	52.0	46.0	47.6	42.8	43.5	45.5	42.0	41.7	43.5	
Bucharest-Ilfov	37.3	34.0	40.3	32.7	29.7	31.4	30.7	25.1	20.5	
South-West Oltenia	57.0	56.6	53.2	47.5	45.8	48.4	44.6	40.9	41.9	
West	33.0	34.3	31.8	36.2	34.6	41.7	40.4	40.1	31.7	
Total	47.0	44.2	43.0	41.5	40.9	43.2	41.9	40.3	37.3	

Source: our elaboration on data Romanian National Institute of Statistics on the website <http://statistici.inssse.ro/shop/?lang=en>

ly distributed the effect is a territorial imbalance able to foster an exodus from rural areas. The European Union, through its financial funds and specific subsidies towards the primary sector, both during the pre-accession phase of EU enlargement (2000-2006) and in the second phase of accession of

Romania in the European Union (2007-2013) has allowed reducing partially socio-economic gaps and imbalances in Romania's rural areas (Figure 4).

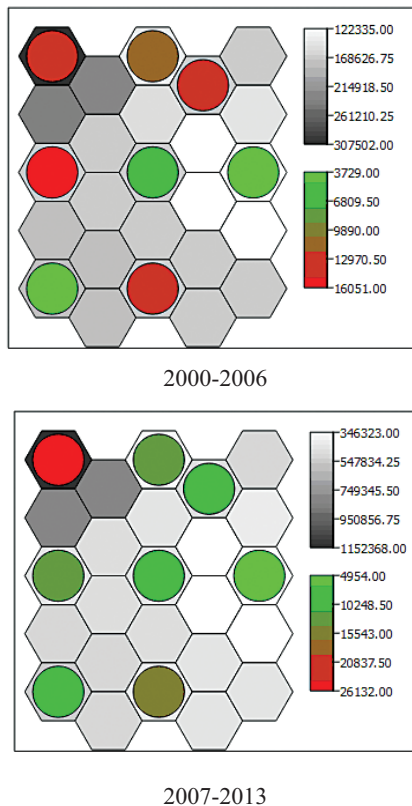


Fig. 3. Results of Kohonen's maps between the variables emigration (coloured scale) and GDP (grey scale)
 Source: our elaboration on data Romanian National Institute of Statistics on the website <http://statistici.inssse.ro/shop/?lang=en>

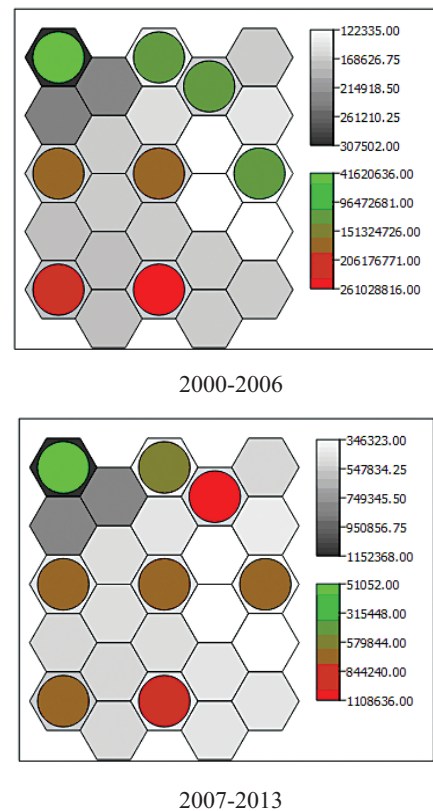
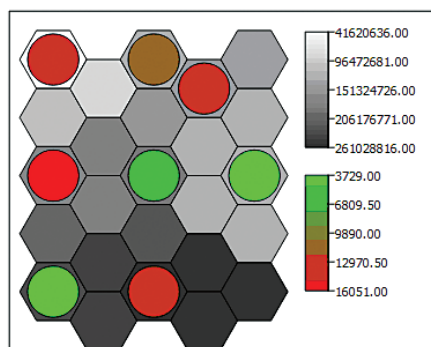


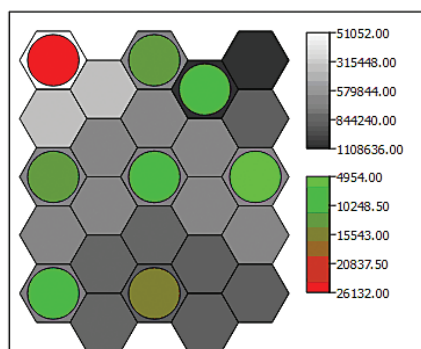
Fig. 4. Findings in Kohonen's maps between the variables financial subsidies allocated by the CAP (2007-2013) or SAPARD programme over the time 2000-2006 (coloured scale) and GDP (grey scale)
 Source: our elaboration on data Romanian National Institute of Statistics on the website <http://statistici.inssse.ro/shop/?lang=en>

Findings in these two variables have pointed out an indirect correlation; hence, the poorer are the regions the higher are the financial supports allocated by the European Union in favor of farmers and rural territories. In general, Romanian rural areas characterized by the highest levels of emigration were also those that benefited to significant financial subsidies allocated by the European Union in order to halt and to contrast the exodus from the countryside (Figure 5). This has been particularly true analyzing outcomes assessed in the seven-year time 2007-2013.

Findings over the time 2007-2013 have corroborated the hypothesis according to which the exodus from Romanian rural and agricultural areas was an irreversible process and against it rural development policies have had a modest impact. In the period 2000-2006, the European Union has sought to concentrate its own efforts towards areas at high risk of depopulation by providing



2000-2006



2007-2013

Fig. 5. Kohonen's maps between the variables emigration (coloured scale) and financial subsidies allocated by the CAP and SAPARD (grey scale)

Source: our elaboration on data Romanian National Institute of Statistics on the website <http://statistici.insse.ro/shop/?lang=en>

actions and financial supports pivotal for a structural improvement of agricultural and agro-industrial fabric.

Romanian regions with high rates of unemployment in the period 2000-2014 have pointed out a direct relationship with the variable rate of people at risk of poverty (Figure 6). The Kohonen's maps have shown that the counties with rates of unemployment above the national average have had the highest potential poverty risk situations.

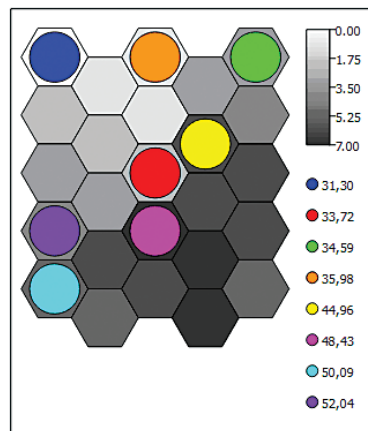
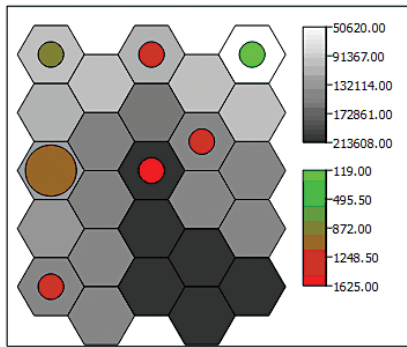


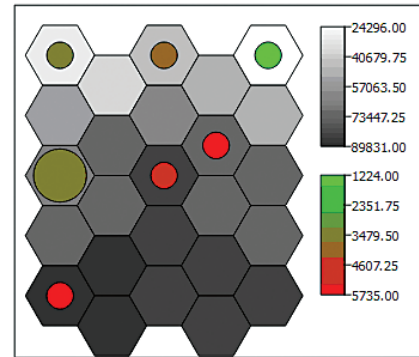
Fig. 6. Main relationships in Self-Organizing Maps between the variables ratio of unemployment (grey scale) and percentage of people at risk of poverty (coloured scale) over the time 2000-2014

Source: our elaboration on data Romanian National Institute of Statistics on the website <http://statistici.insse.ro/shop/?lang=en>

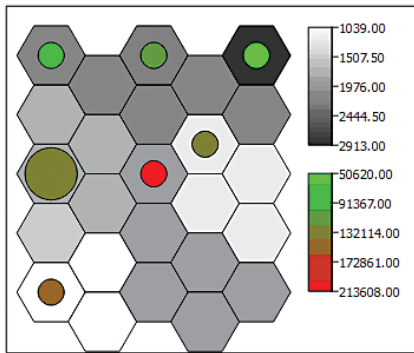
The SOMs have also highlighted an improvement in employment opportunities in all the Romanian regions over the time 2000-2014, although in some regions the highest incidence of unemployed people has had a nexus with the variable level of wealth in terms of Agrarian Domestic Product (Figure 7). Furthermore, the largest migratory flows were found in the Romanian regions with the highest value of unemployed people. Summing up, the emigration has affected Romanian territories with low levels of wealth produced by the primary sector as gross domestic product. Therefore, where agricultural activity has a modest impact on the level of income in terms of Gross Domestic Product, which is typical of rural areas and in particular in less favored rural territories, the migration flows and the levels of unemployment have been higher.



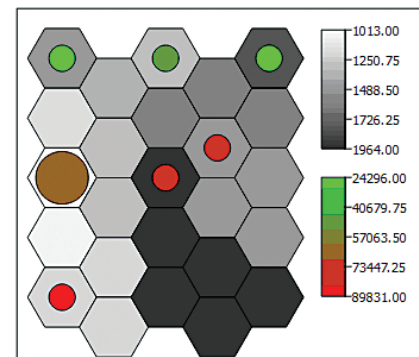
People unemployed (grey scale) and Agrarian Gross Domestic Product (coloured scale) year 2000



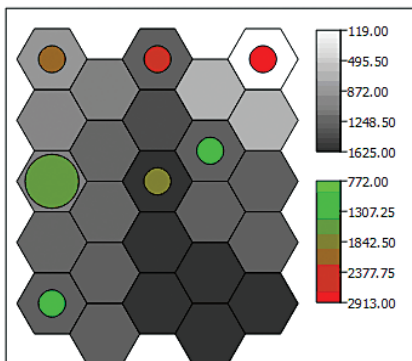
People unemployed (grey scale) and Agrarian Gross Domestic Product (coloured scale) year 2014



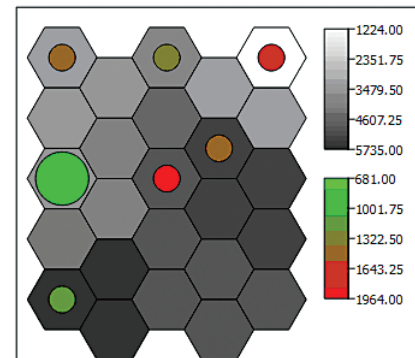
Emigrated people (grey scale) and unemployed people (coloured scale) year 2000



Emigrated people (grey scale) and unemployed people (coloured scale) year 2014



Agrarian Gross Domestic Product (grey scale) and emigrated people (coloured scale) year 2000



Agrarian Gross Domestic Product (grey scale) and emigrated people (coloured scale) year 2014

Fig. 7. Comparing 2000 and 2014 findings in Kohonen's maps among the variables unemployed people, Agrarian Gross Domestic Product and emigrated people in all Romanian regions

Source: our elaboration on data Romanian National Institute of Statistics on the website <http://statistici.INSSE.ro/shop/?lang=en>

Conclusions

The analysis has pointed out as there are several and significant socio-economic imbalances between different Romanian regions, which arose over the time, mainly in rural areas and agricultural territories that have been more disadvantaged than the urban ones with more than 30% of people at a severe risk of poverty and permanent emigration.

In the pre-accession phase of the European Union enlargement, positive was the impact of EU funds aimed at reducing socio-economic and development gaps; therefore, it would be desirable, both from national and European authorities, to increase a more efficient use of European funds, in particular some of them allocated with the purpose of financing the rural and agrarian development, both in supporting population in less favored rural areas and also in modernizing farms, increasing their level of land capital endowment as well.

Summing up, findings have showed that the variable per capita wealth and unemployment rate have acted predominantly on the Romanian development paths in rural areas and in agricultural territories, conditioning their performances both over the time and also among Romanian regions. In fact, the central region and the counties near the capital Bucharest have highlighted as there is a different reactivity among Romanian regions as a consequence of the impact of many external socio-economic and demographic variables on the general socio-economic path of development.

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