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CONSUMPTION OF FOOD IN THE EU BY THE DEGREE OF URBANIZATION: DATA VISUALIZATION AND CLUSTER ANALYSIS OF THE EU SAMPLE

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ABSTRACT

This paper examines the consumption of one of the COICOP classes – food and non-alcoholic beverages – by the degree of urbanization on the sample of EU countries in three periods – 2005, 2010, and 2015. The share of this class in total consumption of cities, towns, and suburbs and rural areas presents the second largest item of the total consumption of all structures in question. They examined the key variable creates an input to the analysis stated in the paper. First, the data visualization is realized by creating maps of scaled consumption of food and non-alcoholic beverages in cities, towns, and suburbs and rural areas in the three periods – 2005, 2010, and 2015. The spatial distribution of data shows, that higher shares of consumption of food and non-alcoholic beverages are obtained in CEE and southern countries in all structures and all periods. Considering that consumption of food and non-alcoholic beverages is negatively correlated with GDP per capita or household expenditure per capita it is possible to conclude that countries with lower levels of GDP per capita spend more on goods of daily use. Second, based on k-means clustering, cluster analysis is stated. Similarities between EU countries in the consumption of food and non-alcoholic beverages by the degree of urbanization and with respect to socio-economic conditions are investigated. Clusters are made for all three monitored periods. In 2005 and 2010 five clusters were identified, in 2015 their number has been reduced to four. Similarities between EU countries in the consumption of food and non-alcoholic beverages by the degree of urbanization change through time. The delayed effect of the financial crisis may explain observed changes. The obvious relocation of countries is evident when comparing clusters in the period 2010 and 2015. Besides it, the most stabile cluster is the cluster, which contains core EU countries.

Keywords: city; suburb; rural area; cluster analysis; COICOP

INTRODUCTION

Currently, tendencies towards the growth of cities, towards the urbanization in the European Union (EU) countries and global terms are evident. The importance of cities relies on the concentration of GDP, work places, and social and cultural infrastructure. On the sample of EU countries, the paper compares a very important part of consumption – consumption of food and non-alcoholic beverages by the degree of urbanization in EU countries. Consumption of food is an inevitable part of human consumption. In EU countries, in 2005, 2010 and 2015 it creates in average 16.1% of the total consumption of cities, 17.6% of the total consumption of towns and suburbs and 19.4% of the total consumption of rural areas (respecting the classification of consumption known as the Classification of individual consumption by purpose, abbreviated as COICOP, for more details see Table 1) **(European Commission, 2019a)**. Besides consumption related to housing, water, electricity, gas, and other fuels, it presents one of the highest items of consumption at all degrees of urbanization. Noticeably, it varies by the degree of urbanization.

Currently, the field of urbanization is widely examined by empirical evidence. **Balk et al. (2018)** mention that most of the future population growth will take place in cities. However, the movement to the cities and their attraction is discussed in an earlier paper of **Yap (1977)**. Since then, cities became a focus of research. The size and prosperity of cities are stressed by **Batty (2011)**, the "New science of cities" is presented in **Batty (2013)**.

However, the urbanization is often examined in connection with economic performance. According to **Bertinelli and Black (2004)**, urbanization and economic growth are positively linked to each other. But as **Poelhekke (2011)** stresses, the urbanization can accelerate even under the worsening economic conditions due to rural-urban migration. Similarly, **Chen et al. (2014)** conclude that expected economic benefits from accelerated urbanization are not obtained in certain cases. They identify a group of countries where the relationship between the economic growth and growth of urbanization is not statistically significant. **Jedwab, Christiaensen, and Gindelsky (2017)** focused on such terms as rural push and urban pull factors in connection with the rural-urban migration. They deliberate over the third factor influencing

the rapid urbanization, urban push factor, which covers the rapid internal urban population growth. The large body of scientific papers is dedicated to the impact of further urbanization on the environment, e.g. **Borck and Pflüger (2019)**, **Yazdi and Dariani (2019)**, **Raheem and Ogebe (2017)** or **Marlier et al. (2016)**.

The European Commission (2019b) monitors the urbanization at the global and EU levels. Expected results of urban sprawl (continuing urbanization) describe a situation, when the urban population reaches 60% by 2030 and 68.4% by 2050. The economic power of cities is broadly discussed because it is estimated that they generate 80% of all economic growth. However, the topic of urbanization in Europe has been a point of interest for a long time. **Enyedi (1990)** mentions that East-Central European countries (socialistic countries) replicated the global process of urbanization, but it was influenced by specific factors related to their history and partisan ideology. Urban sprawl in the European Union was investigated by **Patacchini et al. (2009)**. Urban population trends are discussed in **Kabisch and Haase (2011**). Growth of cities in EU countries in the period of 1990 – 2000 and 2000 – 2006 was investigated by **Haase, Kabisch and Haase (2013)**.

Consumption of food in EU countries is an object of many papers, and it is monitored by the European Commission. The convergence of consumer attitudes to food in the EU was examined in **Trail (1998)**. Since then, many research papers with research objects related to food consumption in EU countries were published (e.g. **Dudek and Koszela, 2013**; **James, Lomax and Birkin, 2019)**. European food consumption databases are under scrutiny in **Le Donne et al. (2011)**. European Food Safety Authority **(EFSA, 2019)** collects data on food-related data. Household expenditure by the consumption purpose (COICOP) is provided by Eurostat **(European Commission, 2019c)**. Thus, even though consumption of food and non-alcoholic beverages by the degree of urbanization is monitored in EU countries (e.g. in the **European Commission, 2019a)**, it is not under the systematic surveillance of empirical evidence.

The paper's motivation is driven by the evidently increasing role of urbanized structures. The paper aims to elicit, if there are any differences in food consumption in differently urbanized structures of EU countries. Correspondently, using the cluster analysis, EU countries are divided into more homogenous groups based on consumption of food by the degree of urbanization and by selected macroeconomic variables in the three periods (2005, 2010 and 2015), from which one is linked to the period immediate to a recent financial crisis.

Paper is organized in the following manner. After the part Introduction, scientific hypotheses of research are listed. Next, the chapter Material and Methodology explains the data and instrumentation used in the paper. Results and Discussion present and discuss results obtained in the provided analysis. The paper is ended by Conclusion and References.

Scientific hypotheses

Consumption of food and non-alcoholic beverages increases with the decrease in the degree of urbanization.

In cities, the share of consumption of food and non-alcoholic beverages in total consumption is lower than in other structures.

Similarities between EU countries in the consumption of food and non-alcoholic beverages by the degree of urbanization change in respect of the recent financial crisis.

The financial crisis in 2009 influenced the consumption of all structures at all degrees of urbanization. Correspondently changes contain clusters.

Table 1 Consumption shares of EU countries (in %) on the basis of COICOP classification and by the degree of urbanization.

COICOP	Cities	Towns and suburbs	Rural areas
Food and non-alcoholic beverages	16.1	17.6	19.4
Alcoholic beverages, tobacco and narcotics	2.5	2.6	2.7
Clothing and footwear	5.3	5.3	5.0
Housing, water, electricity, gas and other fuels	29.5	27.2	26.7
Furnishings, household equipment and routine household maintenance	5.0	5.3	5.3
Health	3.6	3.5	3.6
Transport	11.0	12.4	13.1
Communications	3.6	3.6	3.5
Recreation and culture	8.3	7.9	7.2
Education	1.3	1.0	0.9
Restaurants and hotels	6.0	5.4	4.9
Miscellaneous goods and services	7.7	7.9	7.6
Total	99.9	99.7	99.9

Note: Averages are computed for 2005, 2010 and 2015 employing all EU countries; light grey indicates the lowest values, dark grey indicates the highest values, unknown consumption is excluded.

MATERIAL AND METHODOLOGY

The research involved various types of data, but all of them are extracted from the Eurostat database. The three degrees of urbanization are distinguished. The most urbanized are cities. The degree of urbanization diminishes in towns and suburbs and the rest is concerning rural areas. Data related to consumption by the degree of urbanization are covered in **(European Commission, 2019a)**. Data mentioned hereinbefore are classified according to the COICOP. Here, data are collected in five-year intervals. Hence, years 2005, 2010 and 2015 are employed in research. This is mainly influenced by the incomplete database in previous years and thus the aim to minimize the occurrence of missing data in the panel. For the research purpose, the most important of them are data on the share of food and non-alcoholic beverages consumption in total consumption of all types of urbanization structures. The socio-economic conditions of EU countries are expressed employing the data on GDP, household expenditure, unemployment rate, inflation rate and country size (population). These data are covered in **(European Commission, 2019d)** and **(European Commission, 2019e)**. GDP at market prices is expressed in per capita terms. Final consumption expenditure of households is expressed in per capita terms, too. The annual average of the unemployment rate is expressed as the percentage of the active population. Inflation is based on the food price monitoring tool, expressed as Harmonized Index of Consumer Prices (HICP, 2015 = 100) for the COICOP class of Food in the last month of the respective period (2005M12, 2010M12 and 2015M12). Country size employs the variable of the total population on 1 January.

Statistical analysis

Respecting the paper goal, two main scientific instruments are used to provide the analysis of food and non-alcoholic beverages consumption in EU countries.

First, the creation of maps serves to a visualization of the differences in the spatial distribution in food consumption by the degree of urbanization in EU countries. Maps are created using the R program for statistical computing and graphics **(R Development Core Team, 2019)**. It is a free software environment. The latest R version 3.6.1., released on July 5, 2019, is employed in the research. Packages rgdal, shape and map tools serve to the map creating.

Second, cluster analysis is realized to find similarities/differences between the consumption of food and non-alcoholic beverages by the degree of urbanization in EU countries in 2005, 2010 and 2015. Cluster analysis is provided in the R version 3.6.1, packages class, cluster, pvclust, mclust, stats, graphics, maps, LLAhclust and shapefiles. In general, the method of clustering objects into groups (clusters) is based on the principle of obtaining the highest possible similarity inside the group and the lowest similarity between different groups. In this paper, the method of k-means clustering, introduced by **MacQueen (1967)**, is used. It is an iterative optimization method, which starts from an initial division of object into *k* clusters. In a k-means clustering, the number of centroids is defined in the expertise of the author. Consequently, the number of centroids, which present a real or imaginary center of cluster, reduces the number of clusters. After the definition of the number of centroids, Euclidean distances between each object and centroids are computed. The object is allocated to the nearest initial centroid. In the next step, a new centroid for each cluster is computed. In a stepwise procedure, distances between each object and each centroid are computed again. In case a certain object is closer to another centroid, as it was in the previous step, it is shifted to another cluster. Thus, objects in clusters are rearranged. The aforementioned procedure is repeated until the rearrangement of clusters stops. The k-means clustering depends on the order of the object, thus the locally optimal solution is achieved. The k-means clustering is in details processed e.g. in **Rokach and Maimon (2005)**, **Stankovičová and Vojtková (2007)** or **Řezánková, Húsek and Snášel (2009)**.

RESULTS AND DISCUSSION

Analysis based on data visualization (maps)

The expectation that in cities the share of consumption of food and non-alcoholic beverages in total consumption is lower than in other structures has been confirmed. The combination of data extracted from **(European Commission, 2019a)** and **(European Commission, 2019c)** is projected in Figure 1. It contains nine maps created for the three degrees of urbanization and three periods.

In 2005, results show that the share of consumption of food and non-alcoholic beverages on total consumption of cities is similar to towns and suburbs, but is lower than in rural areas. It is more evident in the case of Central and East European countries (CEE) of the EU and southern countries of the EU (e.g. Italy, Spain and Portugal).

In 2010, the difference between cities and lower degrees of urbanization becomes more obvious. Higher shares of consumption of food and non-alcoholic beverages are observed in towns and suburbs and rural areas. Again, as it is in a previous period, this is observable in CEE and southern countries of the EU (including France).

In 2015, the distinction between cities, towns and suburbs and rural areas is the most obvious. The given hypothesis has also been confirmed in this case when the share of consumption of food and non-alcoholic beverages in total consumption of cities is lower than in towns and suburbs, and also than in rural areas. Consumption of food and non-alcoholic beverages increases with the decrease in the degree of urbanization. The spatial distribution of consumption of food and non-alcoholic beverages intensity emulates the results reached in 2005 and 2010.

In general, results point to the current advanced socio-economic development of cities described in **Bertinelli and Black (2004)**, **Patacchini et al. (2009)**, **Kabisch and Haase (2011)**, **Haase, Kabisch and Haase (2013)** or **Balk et al. (2018)**. Supposing that the economic activity concentrated in cities leads to higher living standards of the city population, the share of COICOP items on total consumption (see Table 1) emulates the expected behavior of developed societies. In comparison with lower degrees of urbanization, they spend more money on recreation, education, hotels and restaurants and housing including fuels.

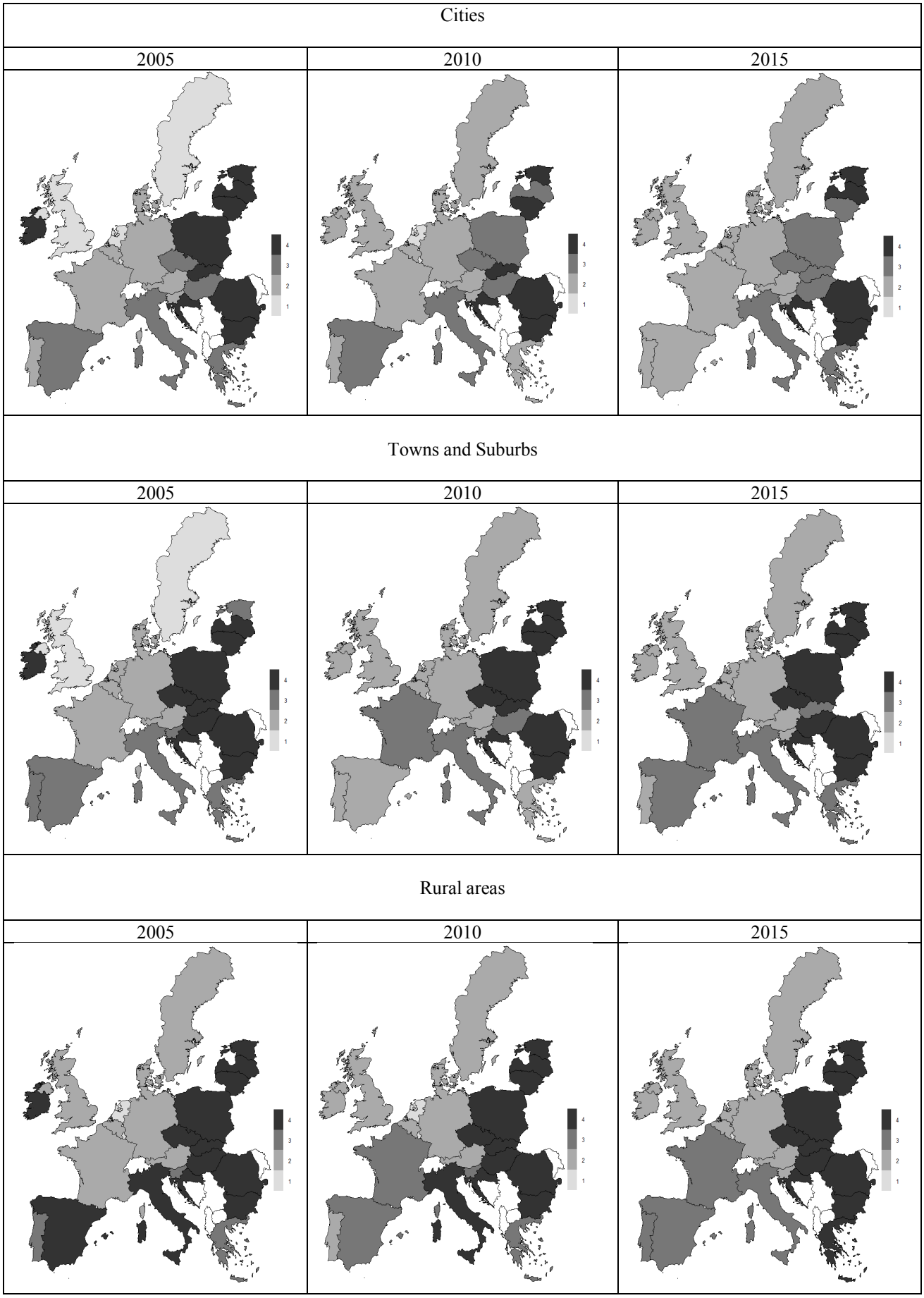

Figure 1 A comparison: Intensity of food consumption by the degree of urbanization in 2005, 2010 and 2015. Note: Scale: (1) the lightest shadow of grey refers to values lower than 0.1 (or 10%), (2) refers to 0.1 – 0.15, (3) refers to 0.15 – 0.2, (4) the darkest shadow of grey refers to values higher than 0.2.

Besides it, certain other common tendencies may be recognized. The intensity (share in total consumption) of food and non-alcoholic beverages consumption is higher in CEE countries. It may be explained by GDP, income and living standards in CEE countries, which, in fact, overcame the transition in the last decades. As mentions by **Enyedi (1990)**, CEE countries "replicated" the trend of urbanization. The urban sprawl mentioned in **Patacchini et al. (2009)** or the growth of cities, examined by **Kabisch and Haase (2011)** and **Haase, Kabisch and Haase (2013)** are present in these countries, too. However, a certain delay in the level of economic development in comparison with the core EU countries is evident. Higher values of the food and non-alcoholic beverages consumption in mentioned countries are still preferred to goods and services of no daily pattern consumption.

Cluster Analysis

Results of cluster analysis present clusters of EU countries, which are homogenous in consumption of food and non-alcoholic beverages by the degree of urbanization (cities, towns and suburbs and rural areas), GDP per capita, household expenditure per capita, unemployment rate and inflation on food. Table 2 displays the correlation coefficients of the mentioned variables.

Using the k-means clustering, EU countries are clustered into five clusters in 2005 and 2010 (see Figure 2 and Figure 3) and into four clusters in 2015 (see Figure 4).

The content of clusters in 2005 is the following:

1) Poland, Slovakia, Croatia, Romania, Latvia, Lithuania, Bulgaria.
2) Czechia, Estonia, Hungary, Malta, Slovenia.
3) Germany, France, Italy, United Kingdom.
4) Belgium, Netherlands, Sweden, Finland, Austria, Cyprus, Denmark, Luxembourg.
5) Spain, Portugal, Greece, Ireland.

The content of clusters in 2010 is the following; relocated countries are highlighted in italics:

1) Poland, Slovakia, Croatia, Romania, Latvia, Lithuania, Bulgaria, *Estonia.*
2) Spain, Portugal, Greece, Ireland.
3) Belgium, Netherlands, Sweden, Finland, Austria, Cyprus, Denmark, Luxembourg.
4) Germany, France, Italy, United Kingdom.
5) Czechia, Estonia, Hungary, Malta, Slovenia.

The content of clusters in 2015 is the following; relocated countries are highlighted in italics:

1) Belgium, Netherlands, Sweden, Finland, Austria, Denmark, Luxembourg, *Ireland.*
2) Spain, Portugal, Greece, *Slovenia, Cyprus.*
3) Poland, Slovakia, Croatia, Romania, Latvia, Lithuania, Bulgaria, *Malta, Czechia, Estonia, Hungary.*
4) Germany, France, Italy, United Kingdom.

The hypothesis that similarities between EU countries in the consumption of food and non-alcoholic beverages by the degree of urbanization change through time has been confirmed. The most significant differences are observable comparing the years 2010 and 2015. The influence of the financial crisis in 2009 may be observed in the following period of 2015 when the economic recovery brings certain rearrangements in comparison with the period before the financial crisis (2005). Correspondent changes in the content of clusters reflect the reorganization of results.

Table 2 Correlation matrix of food consumption by the degree of urbanization (cities, towns and suburbs, rural areas) and selected macroeconomic indicators.

	Cities	Towns and suburbs	Rural areas	GDP pc	Household Expenditure pc	Unemployment rate	Inflation on food (HICP)
Cities	1	0.9535	0.9504	-0.7614	-0.8415	0.2729	-0.2269
Towns and suburbs		1	0.9695	-0.7692	-0.8566	0.2548	-0.1737
Rural areas			1	-0.7549	-0.8439	0.2737	-0.2241
GDPpc				1	0.9185	-0.3657	0.2800
Household Expenditure pc					1	-0.3422	0.3166
Unemployment rate						1	0.1512
Inflation on food (HICP)							1

Note: Correlation coefficients; using the observations 1:1 – 28:3; 5% critical value (two-tailed) = 0.2146 for n = 84.

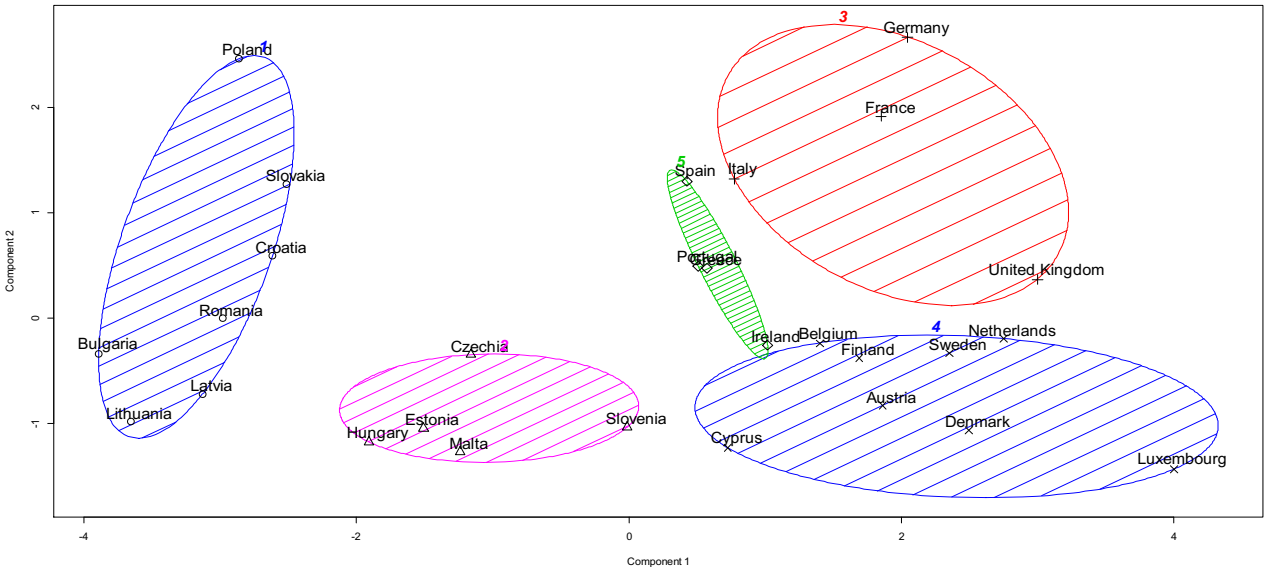

Figure 2 Clustering EU countries in 2005. Note: k-means clustering.

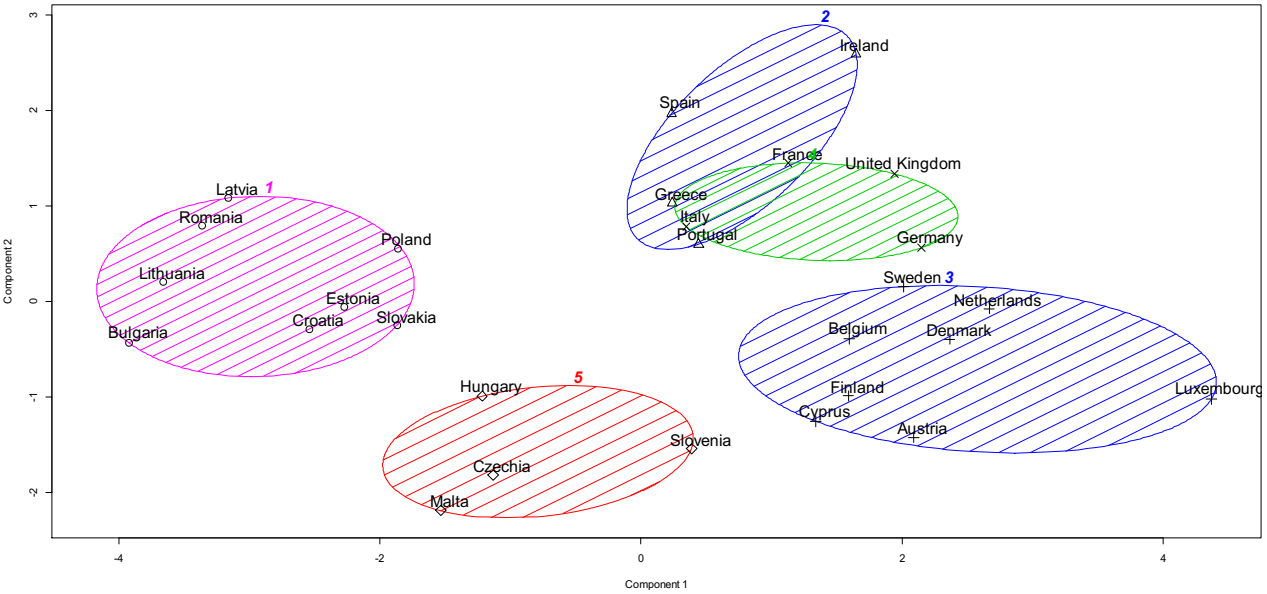

Figure 3 Clustering EU countries in 2010. Note: k-means clustering.

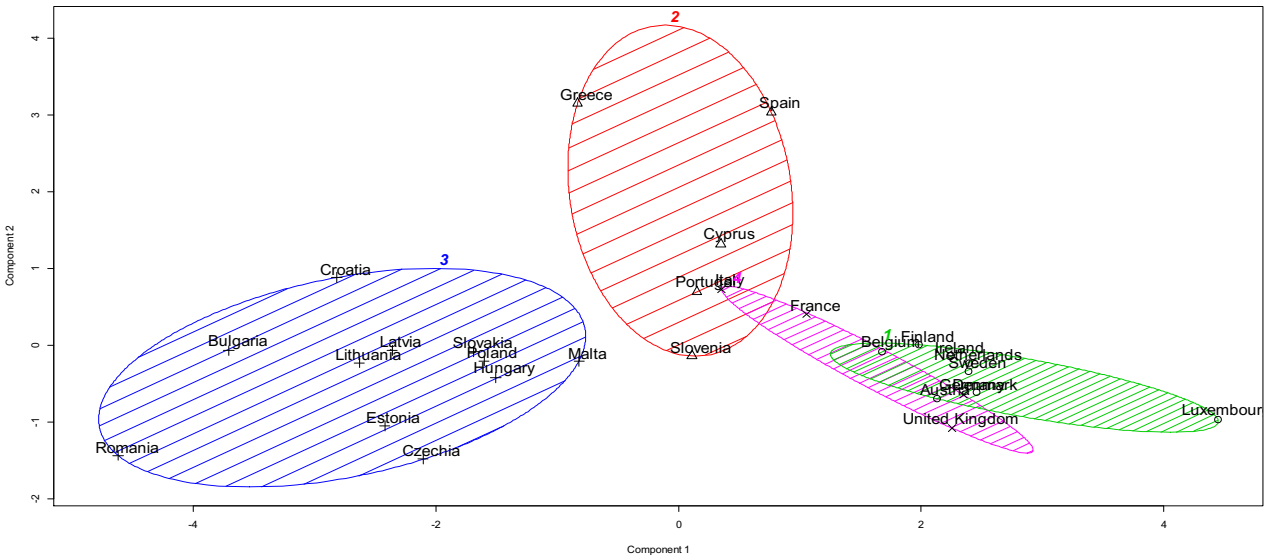

Figure 4 Clustering EU countries in 2015. Note: k-means clustering.

Comparing periods 2005 and 2010, clusters seem to be stable, without evident relocation of countries. Only Estonia moved from the cluster of Czechia, Estonia, Hungary, Malta and Slovenia (2005, cluster 2) to cluster of Poland, Slovakia, Croatia, Romania, Latvia, Lithuania and Bulgaria in 2010 (2010, cluster 1).

In 2015 obvious relocation of countries may be observable. First, contrary to periods 2005 and 2010, four clusters are created. Hence, in 2015 two clusters joined to one (2015, cluster 3). The rest of the clusters stayed almost unchanged.

The most stable cluster is cluster, which contains core EU countries (Germany, France, Italy and the United Kingdom). It remains without any changes.

Ireland moved from the cluster of Spain, Portugal, Greece and Ireland (2010, cluster 2) to cluster of Belgium, Netherlands, Sweden, Finland, Austria, Denmark and Luxembourg (2015, cluster 1).

Slovenia moved from the cluster of Czechia, Estonia, Hungary and Malta (2010, cluster 5) to cluster of Spain, Portugal and Greece (2015, cluster 2).

Cyprus moved from the cluster of Belgium, Netherlands, Sweden, Finland, Austria, Cyprus, Denmark and Luxembourg (2010, cluster 3) to the cluster of Spain, Portugal and Greece (2015, cluster 2).

Clusters presented in Figure 2, Figure 3 and Figure 4 correspond approximately to 77% of the variability of the analysed problem.

Chen et al. (2014) examined the worldwide urbanization by comparing the year 1980 and 2011. According to their results, current EU member countries did not overcome a dramatic wave of urbanization when comparing e.g. to China or Central Africa. At the base of Figure 1, it is obvious that the intensity of the consumption of food and non-alcoholic beverages changed in the cities predominantly. This is observable in 2015. The relocation of countries in the cluster analysis (see Figure 2, Figure 3 and Figure 4) is thus importantly influenced by other variables of macroeconomic nature extracted from **(European Commission, 2019d)** and **(European Commission, 2019e)**. As many of the created clusters are sensitive to changes in macroeconomic conditions, the stabile cluster of core EU countries resists external shock in the form of a financial crisis.

Research on household consumption in EU countries provided by **Dudek and Koszela (2013)** points to certain accordance with the results of the cluster analysis. These authors mention similarities between the Czech Republic and Estonia (in this research both involved in cluster 3 in 2015), Cyprus, Greece and Portugal (cluster 2 in 2015) or Poland, Hungary and Slovakia (the cluster 3 in 2015). Although the field of food consumption is not so rarely employed to the researches (mainly as the COICOP element, e.g. **Dudek and Koszela, 2013** or **James, Lomax and Birkin, 2019**), the connection of the consumption of food and degree of urbanization stays unique.

CONCLUSION

Tendencies towards urbanization are observable all over the world. The increased role of cities is evident also in the EU. This paper examines the consumption of the COICOP class – food and non-alcoholic beverages by the degree of urbanization on the sample of EU countries. As data shows, the share of an examined class of COICOP in total consumption of cities, towns, and suburbs and rural areas presents the second largest item of the total consumption of all structures in question.

This paper examines two scientific hypotheses. First, the consumption of food and non-alcoholic beverages increases with the decrease of urbanization degree. For this purpose, data visualization is employed. Maps are created based on scaled consumption of food and non-alcoholic beverages in cities, towns, and suburbs and rural areas in the three periods – 2005, 2010, and 2015. Nine maps are created. The spatial distribution of data shows that higher shares of consumption of food and non-alcoholic beverages are obtained from CEE and southern countries in all structures and all periods. Considering that consumption of food and non-alcoholic beverages is negatively correlated with GDP per capita or household expenditure per capita, it is possible to conclude that countries with lower levels of GDP per capita spend more on goods of daily use. Finally, in this case the hypothesis has been confirmed. In cities, the share of consumption of food and non-alcoholic beverages in total consumption is lower in comparison with other structures.

Second, the scientific hypothesis stresses the potential change of similarities between EU countries in the consumption of food and non-alcoholic beverages by the degree of urbanization in respectthe of recent financial crisis. To this purpose, the cluster analysis is provided in the research based ons of k-means clustering, similarities between EU countries in the consumption of food and non-alcoholic beverages by the degree of urbanization and with respect to socio-economic conditions are investigated. However, the inter-period comparison of cluster constitution (clusters are made for the all three monitored periods) is made. Obtained results show that similarities between EU countries in consumption of food and non-alcoholic beverages by the degree of urbanization change through the time. Also in this case the scientific hypothesis has been confirmed. The delayed effect of financial crisis may explain observed changes. Obvious relocation of countries is evident when comparing clusters in period 2010 and 2015. Besides it, the most stabile cluster is a cluster, which contains core EU countries (Germany, France, Italy and the United Kingdom).

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