CLUSTER AND MULTICRITERIAL COMPARATIVE REGIONAL ANALYSIS – CASE STUDY OF CROATIAN COUNTIES

Elza Jurun
University of Split/Faculty of Economics
Matice hrvatske 31, 21000 Split, Croatia
Phone: ++ 385 21 430 648; E-mail: elza@efst.hr

Snježana Pivac
University of Split/Faculty of Economics
Matice hrvatske 31, 21000 Split, Croatia
Phone: ++385 21 430 645; E-mail: spivac@efst.hr

Abstract

Croatia as EU accession country is divided into three Nomenclature des unites territoriales statistiques (NUTS 2) regions which are quite different from twenty one official administrative Croatian Counties. Furthermore, Croatian Counties show significant economic and social disproportions. These disproportions are in the focus of the extended on-going scientific research. The focus of this paper is regional multimethodological approach and its results comparative analysis. After Croatian Counties classification by hierarchical Cluster analysis, multicriterial comparative approach is used. Weighting process within Croatian Counties ranking is based on statistical linkage of a set of regional variables (regional GDP per capita, employment, gross investment, production of more important agricultural products, GVA per person employed, construction works value, exports, imports, foreign tourists arrivals, foreign tourists nights, ecology…). Subsequently, comparative rank analysis is realized by rank correlation coefficient hypothesis testing and Friedman test. At the end of this research phase all multimethodological approach results are compared with existing regional administrative division of Croatian territory.

Key words: *Croatian counties, Regional development indicators, Cluster analysis, Multicriterial comparative method*

1. INTRODUCTION

Croatia as EU Accession Country from the period when its efforts to fulfill numerous EU accession requirements have been increased, continually adjusts its development aims to EU regional policy. From 1993 to 2006 more than 1/3 of total EU funds budget was orientated to instruments of equability of regional cohesive policy. Because of such importance given to regional cohesive development, Croatian development aims as well as Croatian development instruments are focused to promoting the development and structural adjustment of regions whose development is lagging behind, converting regions seriously affected by industrial decline, combating long-term unemployment, facilitating the occupational integration of young people and speeding up the adjustment of agricultural structures.

At the end of the period of transition economy, Croatia confronts with challenges and problems as modern East European societies. Nowadays in global crises environment Croatia, as regional economic leader, pretends to become a member of developed European countries community.

Although as EU accession country Croatia is divided into three NUTS 2 (from French language - Nomenclature des unites territoriales statistiques) regions, twenty one Croatian Counties show significant economic and social disproportions. These disproportions are in the focus of extended on-going scientific research. In this research phase integral Croatian Counties model is estimated by multiple regression. In multiple regression model it is estimated how regional GDP per capita as regresand variable depends about a set of independent regional variables (employment, gross investment, production of more important agricultural products, GVA per person employed, value of construction works, exports, imports, foreign tourists arrivals, foreign tourists nights, ecology…).

The comparative analysis has been upgraded by cluster analysis whose results confirm general hypothesis that official Croatian regional county structure is more realistic according relevant regional development indicators in comparison to NUTS 2 regions. Cluster analysis is used to look for groups of counties with similar levels of socio-economic development. Multivariate techniques were successful in identifying the main axes of socio-economic characterisation and the regions of the observed counties with differing degrees of development. The new methodology for spatial-economic entities' classification enables a much more useful characterisation of the territory for policy-making purposes. It is necessary to emphasize that the whole methodological procedure is done upon data base of real regional indicators. Unfortunately, the data base does not consist of recent indicators because of Croatian official statistics data time lag. That is why the latest year with complete data for each Croatian county was 2005 and these indicators are taken as inputs for this research.

In spite of division into three NUTS 2 regions of Croatia as EU accession country, for the purpose of this phase of research Croatia is divided into twenty one counties: County of Zagreb, County of Krapina-Zagorje, County of Sisak-Moslavina, County of Karlovac, County of Varaždin, County of Koprivnica-Križevci, County of Bjelovar-Bilogora, County of Primorje-Gorski kotar, County of Lika-Senj, County of Virovitica-Podravina, County of Požega-Slavonia, County of Slavonski Brod-Posavina, County of Zadar, County of Osijek-Baranja, County of Šibenik-Knin, County of Vukovar-Sirmium, County of Split-Dalmatia, County of Istria, County of Dubrovnik-Neretva, County of Međimurje, City of Zagreb.

2. METHODOLOGICAL BACKGROUND

- For analyzing, planning and managing with regional GDP per capita in each Croatian county at the beginning of this research, the intention is to define direction and intensity of various partial influences on it. Between regional economic indicators which are measured continuity by official statistics for the purpose of this paper are chosen these ones whose values are published for each of twenty one Croatian county for 2005.

- First of all the classic econometric approach has been used and regional GDP per capita has been defined as a product of chosen regressor variables by multiple regression model.

- In this paper clustering as a type of multivariate statistical analysis has been used as a part of comparative analysis of the results given by different quantitative approaches. It is based on a mathematical formulation of a measure of similarity. The term cluster analysis encompasses a number of different algorithms and methods for grouping objects of similar kind into respective categories.

- Agglomerative hierarchical clustering is a bottom-up clustering method where clusters have sub-clusters, which in turn have sub-clusters, etc. Agglomerative hierarchical clustering starts with every single object in a single cluster. Then, in each successive iteration, it agglomerates (merges) the closest pair of clusters by satisfying some similarity criteria, until all of the data is in one cluster.

A matrix tree plot i.e. dendrogram visually demonstrates the hierarchy within the final cluster, where each merger is represented by a binary tree. The most common distance measurement between data points is the Euclidean distance.

- Distance measurements between clusters have several options. The mean linkage represents the distance between two clusters as the average of the distances between all the points in those clusters. Single linkage shows the distance between two clusters as the distance between the nearest neighbors in those clusters and complete linkage measures the distance between two clusters as the distance between the furthest points in those clusters. By such a clustering this paper offers an option of grouping of Croatian counties.

- After that, the PROMETHEE method, one of the most popular and widely used multicriteria decision-making methods, is employed in the Croatian counties ranking.

The PROMETHEE method is appropriate to treat the multicriteria problem of the following type:

$$Max\{f_1(a),...,f_n(a)|a \in K\}, \tag{1}$$

where K is a finite set of possible actions (here countries), and f_j are n criteria to be maximized. For each action $f_j(a)$ is an evaluation of this action. When we compare two actions, $a, b \in K$, we must be able to express the result of this comparison in terms of preference. We, therefore, consider a preference function P:

$$P: K \times K \rightarrow [0,1], \tag{2}$$

representing the intensity of action *a* with regard to action *b*. In practice, this preference function will be a function of the difference between the two evaluations $d = f(a) - f(b)$, and it is monotonically increasing. Six possible types (usual, U-shape, V-shape, level, linear and Gaussian) of this preference function are proposed to the decision maker. The effective choice is made interactively by the decision maker and the analyst according to their feeling of the intensities of preference. In each case, zero, one, or two parameters have to be fixed:

- q is a threshold defining an indifference area;
- p is a threshold defining a strict preference area;
- s is a parameter the value of which lies between p and q.

Now, we can define a preference index:

$$\Pi(a,b) = \frac{\sum_{j=1}^{n} w_j P_j(a,b)}{\sum_{j=1}^{n} w_j}, \tag{3}$$

where w_j are weights associated with each criteria.

Finally, for every $a \in K$, let us consider the two following outranking flows:

i. leaving flow:

$$\phi^{+}(a) = \sum_{b \in K} \Pi(a,b), \tag{4}$$

ii. entering flow:

$$\phi^{-}(a) = \sum_{b \in K} \Pi(b,a). \tag{5}$$

The leaving flow ϕ^{+} is the measure of the outranking character of *a* (indicates how *a* dominates all other actions of *K*). Symmetrically, the entering flow ϕ^{-} gives the outranked character of *a* (indicates how *a* is dominated by all other actions). The action is better if the leaving flow is higher, and the entering flow lower.

The PROMETHEE I gives a partial reordering of the set of actions in which some actions are comparable, while some others are not. When the decision maker requests the complete ranking, the net outranking flow may be considered:

$$\phi(a) = \phi^{+}(a) - \phi^{-}(a) \tag{6}$$

And the higher the net flow, the better the action is. All the actions of *K* are now completely ranked (PROMETHEE II).

3. CASE STUDY OF CROATIAN COUNTIES

Official indicator for numerous macroeconomic analyses is GDP per capita. Croatia as accession EU country has to fulfill a lot of social, legal and economic presumptions in which GDP per capita is also very important criterion. Moreover, this criterion was superior in the process of classifying Croatian territory into three NUTS 2 regions: North West Croatia, Central East (Pannonian) and Adriatic Croatia.

In this research official national division of Croatian territory into twenty one above mentioned counties is accepted. The main intention is to quantify each partial influence of a set of independent regional variables (employment, gross investment, production of more important agricultural products, GVA per person employed, value of construction works, exports, imports, foreign tourists arrivals, foreign tourists nights, ecology…) to regional GDP per capita. These independent regional variables are chosen because it is possible to form complete data base about them. Namely, only observations of these variables are continual published in the official statistical publications. It is necessary to emphasize either at this point that the latest year with complete data for each Croatian county was 2005 and these indicators are taken as inputs for this research.

3.1. Multiple regression model

It is wise to construct complete matrix of correlation coefficients between all observed variables as groundwork for process of estimating multiple model. First interpretations of correlation coefficients from Table 1 lead to essential conclusion that same variables as for example Production of more important agricultural products and Foreign tourists nights have no important influence on GDP per capita. Moreover, the same variables have no important influence neither on all others regressors variables. The most intensive effect on GDP per capita scope has Exports with coefficient correlation of 0,850. Excluding this effect of Exports, Foreign tourist arrivals has the major influence expressed through partial correlation coefficient. It is necessary to mention that Exports has strong correlation with all other regressors variables while Foreign tourist arrivals has no multicolinearity effect. Multicolinearity effects are the main reason why Stepwise method of selecting regressors variables in the phase of specifying the multiple regression model has selected only two variables as statistical significant for defining GDP per capita scope.

In Table 2 there are the previous results of multiple regression model with noted chosen regressors variables: Exports and Foreign tourist arrivals. Although there are only two regressors variables R-square shows high percentage of regression sum of squares. According to all usual classical statistic indicators this multiple regression model of GDP per capita is significant at each significance level.

Table 1: Correlation matrix of regional variables for Croatian counties in 2005

		GDP per capita, kn	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}
GDP per capita, kn	Pearson Correlation	1,000	,825**	,835**	-,378	,741**	,875**	,850**	,827**	,481*	,419	,814**
	Sig. (2-tailed)		,000	,000	,091	,000	,000	,000	,000	,027	,058	,000
x_1	Pearson Correlation	,825**	1,000	,963**	-,128	,647**	,950**	,966**	,965**	,211	,127	,964**
	Sig. (2-tailed)	,000		,000	,581	,002	,000	,000	,000	,358	,583	,000
x_2	Pearson Correlation	,835**	,963**	1,000	-,172	,679**	,909**	,967**	,997**	,094	,015	,994**
	Sig. (2-tailed)	,000	,000		,455	,001	,000	,000	,000	,687	,948	,000
x_3	Pearson Correlation	-,378	-,128	-,172	1,000	-,146	-,221	-,141	-,177	-,414	-,363	-,150
	Sig. (2-tailed)	,091	,581	,455		,527	,335	,542	,442	,062	,106	,517
x_4	Pearson Correlation	,741**	,647**	,679**	-,146	1,000	,723**	,676**	,684**	,320	,304	,638**
	Sig. (2-tailed)	,000	,002	,001	,527		,000	,001	,001	,157	,181	,002
x_5	Pearson Correlation	,875**	,950**	,909**	-,221	,723**	1,000	,917**	,906**	,426	,341	,904**
	Sig. (2-tailed)	,000	,000	,000	,335	,000		,000	,000	,054	,130	,000
x_6	Pearson Correlation	,850**	,966**	,967**	-,141	,676**	,917**	1,000	,970**	,184	,125	,969**
	Sig. (2-tailed)	,000	,000	,000	,542	,001	,000		,000	,423	,589	,000
x_7	Pearson Correlation	,827**	,965**	,997**	-,177	,684**	,906**	,970**	1,000	,082	,007	,992**
	Sig. (2-tailed)	,000	,000	,000	,442	,001	,000	,000		,723	,977	,000
x_8	Pearson Correlation	,481*	,211	,094	-,414	,320	,426	,184	,082	1,000	,987**	,078
	Sig. (2-tailed)	,027	,358	,687	,062	,157	,054	,423	,723		,000	,737
x_9	Pearson Correlation	,419	,127	,015	-,363	,304	,341	,125	,007	,987**	1,000	-,004
	Sig. (2-tailed)	,058	,583	,948	,106	,181	,130	,589	,977	,000		,987
x_{10}	Pearson Correlation	,814**	,964**	,994**	-,150	,638**	,904**	,969**	,992**	,078	-,004	1,000
	Sig. (2-tailed)	,000	,000	,000	,517	,002	,000	,000	,000	,737	,987	

Note: **. Correlation is significant at the 0.01 level (2-tailed); *. Correlation is significant at the 0.05 level (2-tailed).

x1 - employment; x2 - gross investment (000 kn); x3 - production of more important agricultural products (t); x4 - GVA per person employed (kn); x5 -value of construction works (000 kn); x6 - exports (000); x7 - imports; x8 - foreign tourists arrivals; x9 - foreign tourists nights; x10 - ecology.

Source: www.dzs.hr.

Table 2: Stepwise method variables selection

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	F-test (p-value)
	,912ª	,831	,812	6407,022	0,000

Note: a. Predictors: (Constant), Exports (000 kn), Foreign tourists arrivals

c. Dependent Variable: GDP per capita, kn

Source: www.dzs.hr.

Table 3: Estimated parameters, confidence intervals and collinearity statistics.

Modelª		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B		Collinearity Statistics	
			Std. Error				Lower Bound	Upper Bound	Tolerance	Variance Inflation Factors
	(Constant)	34583,930	1799,482		19,219	,000	30803,357	38364,502		
	Exports (000 kn)	,003	,000	,788	7,992	,000	,002	,004	,966	1,035
	Foreign tourists arrivals	,008	,002	,335	3,401	,003	,003	,012	,966	1,035

Note: a. Dependent Variable: GDP per capita, kn

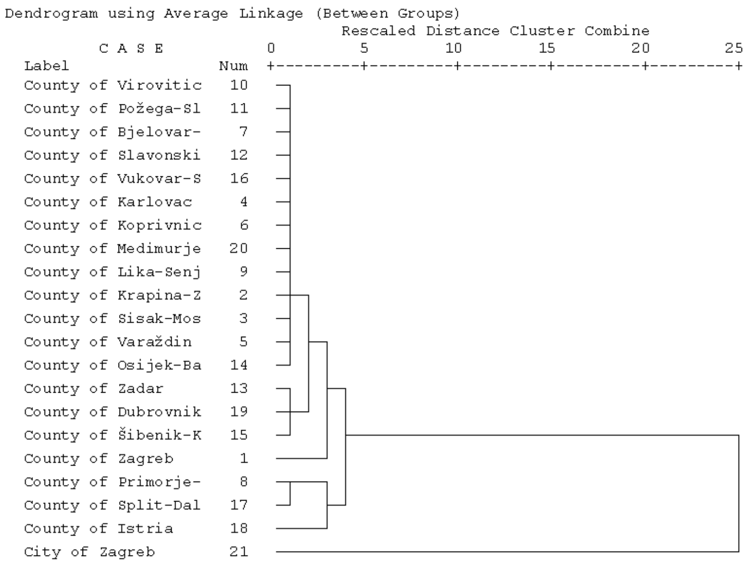
Source: www.dzs.hr.

Estimated parameters in Table 3 shows positive effects of Exports and Foreign tourist arrivals on GDP per capita.

Although both regression parameters are statistical significant, according to standardized coefficient it can be concluded that Exports has stronger influence on regressand variable. Taking into account collinearity statistics it is obvious that model has no multicolinearity problem. According to all standard statistical and econometric tests the estimated model is significant.

3.2. Cluster analysis

After procedure of classic econometric modelling it has been necessary to analyse Croatian counties indicators by Cluster analysis. Hierarchical Cluster analysis procedure has been done using between-groups distance method with Euclidean distance measure[1]. Results are presented by dendrogram on Figure 1.



Source: www.dzs.hr.

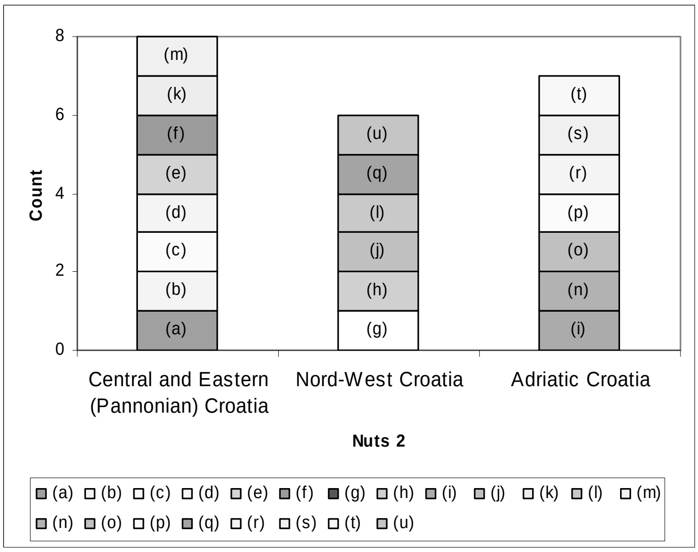
Figure 1: Dendrogram classification of Croatian counties.

In order to make the comparative analysis between official Croatian spacing into 21 counties and official EU regional statistics NUTS 2 division of the same territory within Croatian borders Figure 2 and 3 have been constructed. Comparative analysis results tend to general conclusion that EU regional statistics NUTS 2 Croatian regions are pure administrative division set.

Namely, each of three NUTS 2 Croatian regions is very heterogeneous set of counties diverse according all respectable economic indicators. For example, NUTS 2 Nord-West Croatia consists of these counties: County of Zagreb, County of Krapina-Zagorje, County of Varaždin, County of Koprivnica-Križevci, County of Međimurje and City of Zagreb. Only first and the last of them are homogeneous corpus. As it is obvious from the Figures 2 and 3 other Croatian counties which are according to EU statistics classification in the same NUTS 2 region are quite different from City and County of Zagreb by all development and economic

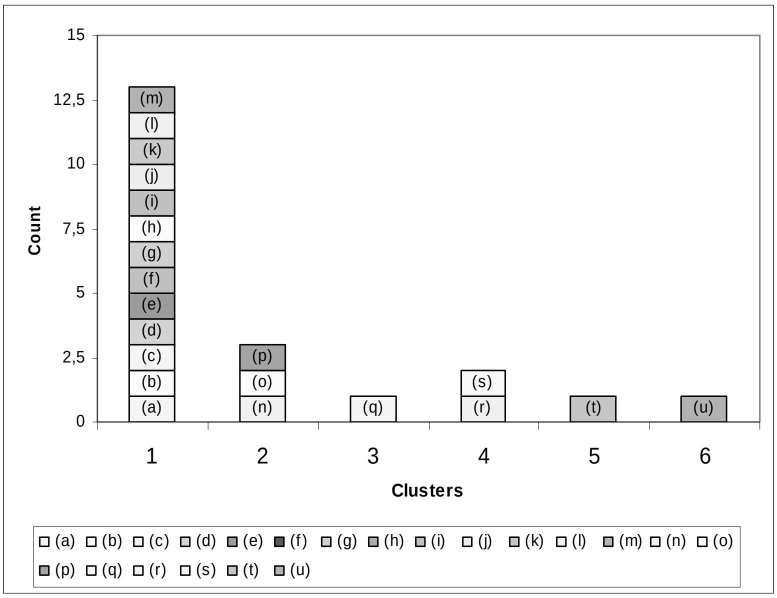
[1] According to K-means cluster method, the counties classification is very similar. ANOVA cluster p-values for all criteria are less then 0.05.

indicators. Furthermore, these four Croatian counties are integral part of the lowest Cluster analysis class (the first bar on the Figure 3).



*Note: County of Virovitica-Podravina (a); County of Požega-Slavonia (b); County of Bjelovar-Bilogora (c); County of Slavonski Brod-Posav (d); County of Vukovar-Sirmium (e); County of Karlovac (f); County of Koprivnica-Križevci (g); County of Međimurje (h); County of Lika-Senj (i); County of Krapina-Zagorje (j); County of Sisak-Moslavina (k); County of Varaždin (l); County of Osijek-Baranja (m); County of Zadar (n); County of Dubrovnik-Neretva (o); County of Šibenik-Knin (p); County of Zagreb (q); County of Primorje-Gorski Kota (r); County of Split-Dalmatia (s); County of Istria (t); City of Zagreb (u).
Source: www.dzs.hr.

Figure 2: *EU regional statistics NUTS 2 Croatian regions.*



*Note: The counties are labeled as on the Figure 2.
Source: www.dzs.hr.

Figure 3: *Croatian counties classification according the set of regional economic indicators.*

The Figure 3 as the final result of the cluster analysis is also authors' suggestion for Croatian regionalization. That's why Cluster analysis, just like classical econometric model confirms general conclusion that EU regional Croatian NUTS 2 spacing has been done according administrative geographic and demographic criteria neglecting socio-economic set of criteria.

3.3. Multivariate ranking

After the analysis has been carried out, the final rank of Croatian Counties according to all regional economic indicators, all indicators without GDP per capita and GDP per capita rank is given in Table 4. Weighting process within Croatian Counties ranking is based on statistical linkage i.e. normed correlation coefficients of a set of regional variables.

Table 4: PROMETHEE II Complete Ranking according to regional economic indicators and GDP per capita ranking.

ALL INDICATORS			ALL INDICATORS (WITHOUT GDP)			GDP PER CAPITA RANK	
RANK	ACTION	PHI	RANK	ACTION	PHI	RANK	ACTION
1.	City of Zagreb	0,60	1.	City of Zagreb	0,79	1.	City of Zagreb
2.	County of Istria	0,37	2.	County of Istria	0,66	2.	County of Istria
3.	County of Primorje	0,32	3.	County of Split-Dal	0,53	3.	County of Primorje
4.	County of Split-Dal	0,31	4.	County of Primorje	0,36	4.	County of Dubrovni
5.	County of Osijek-Ba	0,10	5.	County of Osijek-Ba	0,36	5.	County of Koprivnic
6.	County of Zadar	0,01	6.	County of Varaždin	0,26	6.	County of Lika-Senj
7.	County of Vukovar-	-0,02	7.	County of Sisak-Mos	-0,24	7.	County of Varaždin
8.	County of Slavonski	-0,07	8.	County of Krapina-Z	-0,07	8.	County of Zadar
9.	County of Sisak-Mos	-0,07	9.	County of Međimurj	-0,14	9.	County of Sisak-Mos
10.	County of Varaždin	-0,07	10.	County of Zagreb	-0,15	10.	County of Zagreb
11.	County of Dubrovni	-0,08	11.	County of Zadar	-0,17	11.	County of Split-Dal
12.	County of Šibenik-K	-0,09	12.	County of Karlovac	-0,18	12.	County of Karlovac
13.	County of Zagreb	-0,09	13.	County of Vukovar-	-0,18	13.	County of Međimurj
14.	County of Lika-Senj	-0,10	14.	County of Koprivnic	-0,18	14.	County of Osijek-Ba
15.	County of Krapina-Z	-0,10	15.	County of Šibenik-K	-0,19	15.	County of Šibenik-K
16.	County of Koprivnic	-0,12	16.	County of Slavonski	-0,24	16.	County of Krapina-Z
17.	County of Međimurj	-0,13	17.	County of Virovitic	-0,30	17.	County of Bjelovar-
18.	County of Karlovac	-0,14	18.	County of Dubrovni	-0,33	18.	County of Požega-Sl
19.	County of Virovitic	-0,17	19.	County of Požega-Sl	-0,35	19.	County of Virovitic
20.	County of Požega-Sl	-0,22	20.	County of Bjelovar-	-0,35	20.	County of Vukovar-
21.	County of Bjelovar-	-0,23	21.	County of Lika-Senj	-0,37	21.	County of Slavonski

Source: www.dzs.hr.

City of Zagreb, County of Istria, County of Primorje-Gorski Kotar and County of Split-Dalmatia have the constant and convincing primacy in all rankings. County of Virovitica-Podravina, County of Požega-Slavonia and County of Bjelovar-Bilogora are at the bottom of the all ranks. In the case of ranking according to all regional indicators without GDP County of Lika-Senj is at the end and according to GDP per capita rank the last are County of Vukovar-Sirmium and County of Slavonski Brod-Posavina.

In table 5 there are Spearman correlation coefficients for Croatian Counties rankings. It can be concluded that all coefficients are positive and significant. In spite of varying list of ranking criteria, final results are quite similar and according to Spearman's coefficients they are unambiguous statistically significant.

Furthermore, Friedman nonparametric test confirms above mentioned results in the cases of ranking according to GDP per capita and all other regional socio-economic indicators without GDP as well as when list of ranking criteria consolidates GDP and all other regional socio-economic indicators. Complete results of Friedman test are shown in table 6.

Table 5: Spearman correlation coefficients for Croatian Counties rankings.

			Ranks (all variables)	Ranks (without GDP)	GDP per capita ranks
Spearman's rho	Ranks (all variables)	Correlation Coefficient	1,000	,726**	,477*
		Sig. (2-tailed)	.	,000	,029
		N	21	21	21
	Ranks (without GDP)	Correlation Coefficient	,726**	1,000	,461*
		Sig. (2-tailed)	,000	.	,035
		N	21	21	21
	GDP per capita ranks	Correlation Coefficient	,477*	,461*	1,000
		Sig. (2-tailed)	,029	,035	.
		N	21	21	21

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Source: www.dzs.hr.

Table 6: Friedman test and mean ranks.

Friedman Test		Ranks	Mean Rank
Chi-Square	1,043	Ranks (all variables)	2,14
df	2	Ranks (without GDP)	1,86
Asymp. Sig.	,593	GDP per capita ranks	2,00

Source: www.dzs.hr.

3. CONCLUSION

This paper as a part of en extensive research about Croatian economic challenges within global recession environment has estimation of integral Croatian counties GDP per capita model in its focus. The main intention is to quantify each partial influence of a set of independent regional variables (employment, gross investment, production of more important agricultural products, GVA per person employed, value of construction works, exports, imports, foreign tourists arrivals, foreign tourists nights, ecology…) to regional GDP per capita. Stepwise variable selection method points out that regional GDP per capita is very well explained only by two regional variables: Exports and Foreign tourist arrival. Namely, correlation analysis shows strong multicolinearity effects between Exports and all other regressors variables. Regional Croatian counties GDP per capita model is estimated by classical multiple regression approach.

The Cluster analysis of the same set of Croatian counties according appropriate indicators is done. Complete set of the comparative analysis results confirms general conclusion that EU regional Croatian NUTS 2 spacing has been done according administrative geographic and demographic criteria neglecting socio-economic set of criteria. That is why legal Croatian counties administrative spacing into 21 various counties is nowadays the best reflection of the Croatian territory socio-economic and geographic status by relevant development and economic indicators. The paper is enriched with multicriteria PROMETHEE ranking method. Combining the existing classification and ranking methodologies, originating from different quantitative disciplines, it presents a new method which provides an excellent basis for county assessment. It provides a finding position and ranking of each particular county. Everything in the proposed methodology is transparent and unbiased: inputs, principles, procedures and results. Spearman correlation coefficients and Friedman test confirm that there is no statistical significant difference between ranking Croatian counties according list of criteria consisting all variables, the variables without GDP and GDP per capita ranking. It can be concluded that GDP per capita is the best relevant regional indicator. It is very practical conclusion because GDP per capita is obvious part of numerous national and regional official administrative indicators.

REFERENCES

Anderson, T.W. (2003), *An Introduction to Multivariate Statistical Analysis* (Wiley Series in Probability and Statistics), Wiley-Interscience.

Čižmešija, M. and Kurnoga Živadinović, N. (2002), "Faktorska analiza rezultata konjukturnih testova Hrvatske" *Ekonomski pregled*, 7-8: pp. 684-705.

Fang, K.T. and Yao-Ting, Z. (1990), *Generalized Multivariate Analysis,* Springer-Verlag, New York.

Johnson, R.A. and Wichern, D.W. (2002), *Applied Multivariate Statistical Analysis*, Prentice Hall.

Jurun, E., Pivac, S. and Arnerić, J. (2006), *Primijenjena ekonometrija 1, Kvantitativne financije*. Faculty of economics, University of Split.

Jurun, E. and Pivac, S. (2009), "Multiple Monte Carlo Simulations - Case Study of Croatian Counties", *Proceedings of the 10th International Symposium on Operational Research SOR'09*, Nova Gorica, Slovenia, Semptember 23-25, pp. 507-516.

Loedwijk, B. and Terweduwe, D. (1988), "The Classification of Countries by Cluster and by Factor Analysis". *World Development*, 16(12), pp. 1527-1545.

Central Bureau of Statistics, Republic of Croatia, Čizmović, Ž. at al. (2002), Zagreb, *Projekt nomenklatura prostornih jedinica za statistiku*. http://static.scribd.com/docs/9eg5racvyl7lz.pdf
[Accessed 10/01/10]

Eurostat. http://ec.europa.eu/eurostat/ramon/nuts/introduction_regions_en.html. [Accessed 10/01/10]