MULTIVARIATE AND MULTICRITERIAL FOREIGN DEBT ANALYSIS OF THE SELECTED TRANSITION ECONOMIES

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Abstract

There is a constant evidence of the growth of the foreign indebtedness in all the countries in transition, both EU member states and (pre)accession countries. Status and trends of external debt are important indicators of potential macroeconomic problems, which determines that the management of foreign debt should be a task for all governments. Thus, methodology and measurement of foreign indebtedness is crucial for these countries.

The aim of the paper is to classify, using multivariate cluster analysis, ten chosen countries in transition (Bosnia and Herzegovina, Croatia, Czech, Estonia, Hungary, Latvia, Latvia, Macedonia, Poland, Slovenia) according to the key indicators of the state and trends of foreign indebtedness. In addition, ranking of those countries will be done in relation to the indebtedness indicators by the multicriteria analysis method. Comparative analysis of the results will be done. The advantage of these approaches is reflected in the fact that the analysis, classification and ranking can be done for all countries, based on all indicators of external indebtedness at the same time.

Key words: *Multivariate analysis, Multicriterial analysis, Foreign debt, Transition countries*

1. INTRODUCTION

The importance of the foreign debt and its sustainability in relation to the macroeconomic stability and growth has been rather well explored in the recent economic literature (Mihaljek 2003; Daseking 2002; Knobloch and Haas 2010; Kersan-Škrabić and Mihovilović 2006). Many countries have experienced fast growth due to the foreign indebtedness. Nevertheless, the others have accepted foreign debt as to be able to finance consumption, not investments. Consumption as well as inefficient investments, in turn, do not enable the indebted country to provide means to settle down the debts.

It is essential to maintain the national growth rate above or right bellow the global interest rate. Otherwise, the foreign debt will grow. Current deficit of the balance of payment could be sustainable even in the long run, provided that the foreign debt growth rate is lower than the output growth rate.

Neoclassical growth model assumes that the capital inflow would increase the growth rate in the countries in transition enabling them to converge towards developed economies, EU in particular.

In the majority of the countries in transition there is a strong capital inflow (liberalization of capital account) accompanied with the external and fiscal deficits, low exports and also inflexible exchange rate and labour price (especially in the countries of South East Europe - SEE).

Contrary to the experience of the Central European countries, the neoclassical growth model in the SEE countries has not proven efficient. Indeed, increase of foreign and public debts, as well as preservation of imbalances in prices, do increase risks of investments, bringing into the question macroeconomic stability and sustainable growth.

Therefore, adequate system of measurement, monitoring and statistical analysis of foreign debt appear crucial. It enables the stakeholders creating economic policy to take accurate and right decisions aiming to maintain macroeconomic stability in the short run, as well as to correct structural imbalances in the long run. Thus, the purpose of the paper is to compare, rank and classify a set of the transition countries according to the chosen indicators of foreign debt and in relation to the state and flows of foreign debt. The paper is methodological in nature. It is expected that, taking into account a number of criteria at the same time, combination of classification and ranking methods (multivariate and multicriteria analyses), more complex and in-debt analysis of the foreign debt in the period 2000-2009 would be achieved.

2. DATA AND CRITERIA

There is no unique indicator of indebtedness or liquidity that could be considered as crucial for the assessment of foreign indebtedness. In fact, to this end, a number of indicators as well as specificities and economic features of each country have to be taken into account. In general, indicators could be divided into two main groups: indicators of state and flow and other chosen indicators.

The most important indicators of state are the following:

- The foreign debt and GDP ratio TED/Y (S1), shows the intensity of the burden that the foreign debt poses on the economic activity (GDP) in a country in the current year. According to the criteria of the World Bank (Global Development Finance), the countries are classified as follows: $TED/Y \leq 48\%$ - less indebted country; $48\% < TED/Y \leq 80\%$ - moderate level of indebtedness; $TED/Y > 80\%$ - highly indebted country. The increase of the value of the TED/Y indicates possible problems in the solvency of a country as well as risks related to the ability to service the debt obligations. Having substituted indicators of state by the rates of

foreign debt and GDP in certain period, one can determine the trends in indebtedness: if the GDP growth rate exceeds the foreign debt growth rate, the ability to pay back foreign debts increases, and vice versa.

- Foreign debt and export ratio (TED/E) (S2) – Export of goods and services represents the main source of revenues used to pay back the foreign debt. The ratio between total foreign debt and export shows the extent to which foreign debt burdens the relations with the foreign countries. Favourable foreign trade balance (exports of goods and services exceed imports) makes it easier to handle foreign debt obligations in certain period. According to the World Bank, the countries can be classified as follows: TED/E $\leq$ 132% - less indebted country; 132% < TED/E $\leq$ 220% - moderate indebtedness; TED/E > 220% - highly indebted country. Lower value of this indicator means that country under study is in more favourable situation regarding the ability to serve the foreign debt. In terms of the growth rates, export growth rate higher than the foreign debt growth rate implies better ability to serve foreign debt obligations, and vice versa.

- International reserves and total foreign debt ratio, IR/TED (S3), has a twofold meaning: it indicates the extent to which international reserves "cover" foreign debt on one hand, and the level of the net indebtedness of a country. The former is important for evaluation of solvency and standing of a country under the study towards the foreign countries. For example, if domestic firm cannot meet its obligations towards the foreign lenders (state guarantee provided), the state takes over these obligations and, eventually, serves them using international reserves. This is due to the request of preserving national solvency and standing towards foreign countries, in order to suffer consequences such as exclusion from international capital markets. Level of the net indebtedness of a country represents total foreign debt (TED) of a country reduced by the amount of international reserves.

Indicators of flow:

- Debt service ratio (T1), TDS/E, represents the relationship between the paid obligations related to foreign debt and the exports of goods and services. Having in mind that the export is the main source of revenue (in foreign currencies) needed to pay off foreign debt, this indicator shows the extent to which foreign debt burdens the exports. Higher value of this indicator means that the growth rate of current obligations related to the payment of foreign debt is higher than the growth rate of exports (enlarged, in some countries, for the value of balance of current transfers). In this case, the obligations related to foreign debt imply the amount of actually paid obligations, and not the amount of total obligations due. The difference between these two amounts is defined as unsettled obligations (they are not included in calculation because it would result in unrealistic increase of the debt service ratio value). The experience of the most indebted countries and the countries facing severe problems in debt servicing indicates, in general, that the level of debt service ratio is acceptable if lower than 10%. Debt service ratio higher than 20% implies real threat to the foreign solvency of a country.

- International reserves and foreign debt payments (T2) ratio is calculated as relation between total international reserves of a country and 1/12 of the amount of obligations related to the foreign debt servicing (capital and interest) due in a certain period of time. It shows the number of months during which period the foreign debt could be served using currently disposable amount of the international reserves.

Other indicator is foreign direct investments and GDP ratio (FDI/GDP) – higher values of this indicator imply that the country under study accommodates higher amounts of the long term foreign private capital.

The indicators have been chosen based on the availability of data for the countries under study provided by their national banks and IMF data bases 2010.

3. MULTIVARIATE FOREIGN DEBT ANALYSIS OF THE SELECTED TRANSITION ECONOMIES

3.1. The Elements of Multivariate Analysis

Multivariate analysis (MVA) is based on the statistical principle of multivariate statistics, which involves observation and analysis of more than one statistical variable at a time. In any design and analysis, the technique is used to perform trade studies across multiple dimensions while taking into account the effects of all variables on the responses of interest.

Clustering is a type of multivariate statistical analysis also known as cluster analysis, unsupervised classification analysis, or numerical taxonomy. It is based on a mathematical formulation of a measure of similarity. There are a number of characteristics that distinguish different approaches to cluster analysis. The term cluster analysis (Anderberg 1973) encompasses a number of different algorithms and methods for grouping objects of similar kind into respective categories. A general question facing researchers in many areas of inquiry is how to organize observed data into meaningful structures, that is, to develop taxonomies. In other words, cluster analysis is an exploratory data analysis tool that aims at sorting different objects into groups in a way that the degree of association between two objects is maximal if they belong to the same group and minimal otherwise.

Agglomerative hierarchical clustering is a bottom-up clustering method where clusters have sub-clusters, which in turn have sub-clusters, and so on. 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, or dendrogram, visually demonstrates the hierarchy within the final cluster, where each merger is represented by a binary tree. Connected vertical lines designate joined cases. The dendrogram rescales the actual distances to numbers between zero and 25, preserving the ratio of the distances between steps. The cluster procedure can be described as follows:

- Assign each object to a separate cluster;
- Evaluate all pair-wise distances between clusters;
- Construct a distance matrix using the distance values;
- Look for the pair of clusters with the shortest distance;
- Remove the pair from the matrix and merge them;
- Evaluate all distances from this new cluster to all other clusters, and update the matrix;
- Repeat until the distance matrix is reduced to a single element.

Cluster multivariate analysis can produce an ordering of the objects, which may be informative for data display. Use of different distance metrics for measuring distances between clusters may generate different results. Performing multiple experiments and comparing the results is recommended to support the veracity of the original results. The most common distance measurements between data points are the Euclidean distance and Euclidean squared 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 points in those clusters. Single linkage shows the distance between two clusters as the distance between the nearest neighbours in those clusters, and complete linkage measures the distance between two clusters as the distance between the farthest points in those clusters.

Ward's method (Ward 1963) is distinct from all other methods because it uses an analysis of variance approach to evaluate the distances between clusters. In short, this method attempts to minimize the Sum of Squares (SS) of any two (hypothetical) clusters that can be formed at each step. Cluster analysis does not presuppose any statistical significance, and it is therefore recommended to use appropriate statistical tests in practical analyses. From non-hierarchical methods in practice is mostly used k-means cluster analysis. Advantage and/or lack of this method is that the algorithm requires specifying the number of clusters in advance.

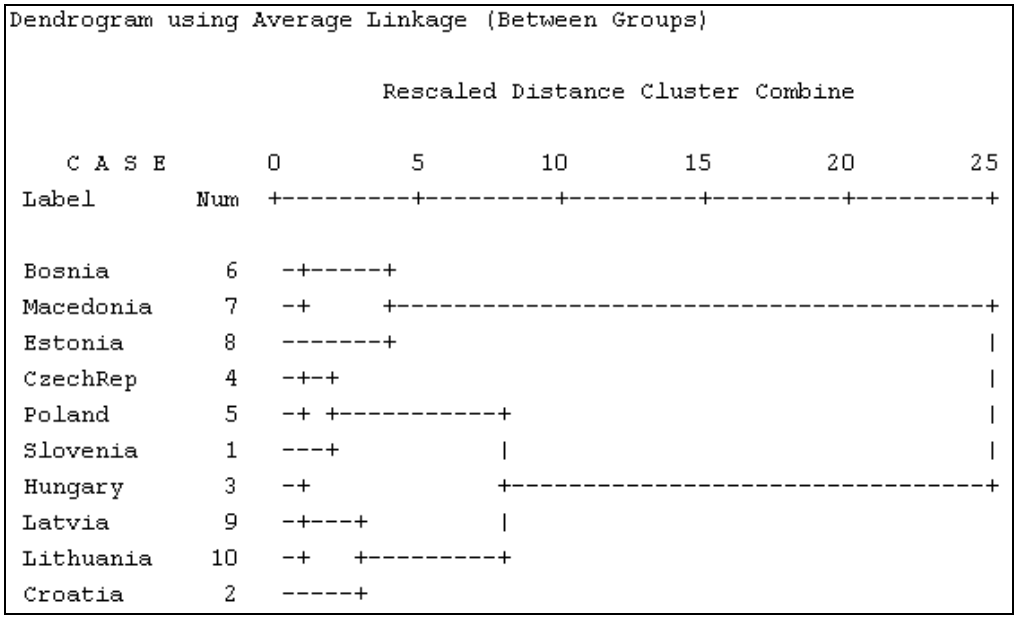
3.1. Classification of Transition Economies According to Foreign Debt Indicators

In this paper the multivariate cluster analysis by Euclidean distance using Average Linkage method is applied for classifying countries (Tomić-Plazibat at al. 2010) in the associated class for 2000, 2004 and 2008.

Appropriate denrdogram for 2000 is shown in Figure 1. According to all state and flow indicators Croatia is most similar to Hungary, Latvia and Lithuania. Bosnia, Macedonia and Estonia are in the separate group. Czech Republic and Poland are particularly similar.

To confirm this classification k-means cluster analysis is also carried out, where 2 clusters are defined. The results of these classifications are shown in Table 1.

It is confirmed that Slovenia, Bosnia, Macedonia and Estonia are in one group and all other countries are in the second group.



Source: Estimated according to the observed countries National Banks data (2010), IMF (2010)

Figure 1: Dendrogram using average linkage (between groups) according to all indicators in 2000.

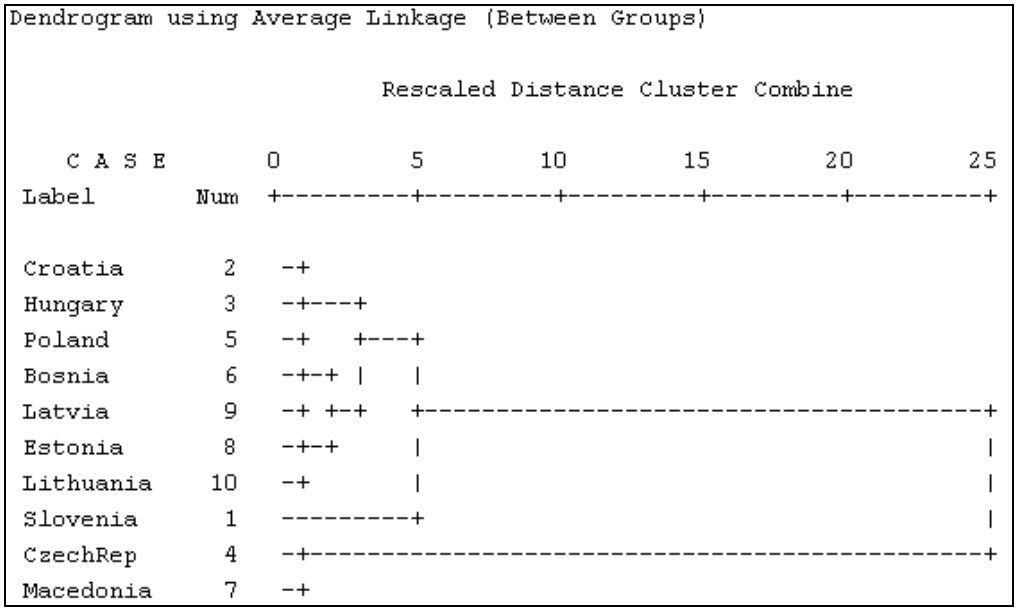
Table 1: Cluster classification using k-means method in 2000, 2004 and 2008.

Countries	2000 Cluster	2004 Cluster	2008 Cluster
Slovenia	1	2	1
Croatia	2	2	1
Hungary	2	2	1
Czech	2	1	2
Poland	2	2	1
Bosnia	1	2	2
Macedonia	1	1	2
Estonia	1	2	1
Latvia	2	2	1
Lithuania	2	2	1

Source: Estimated according to the observed countries National Banks data (2010), IMF (2010)

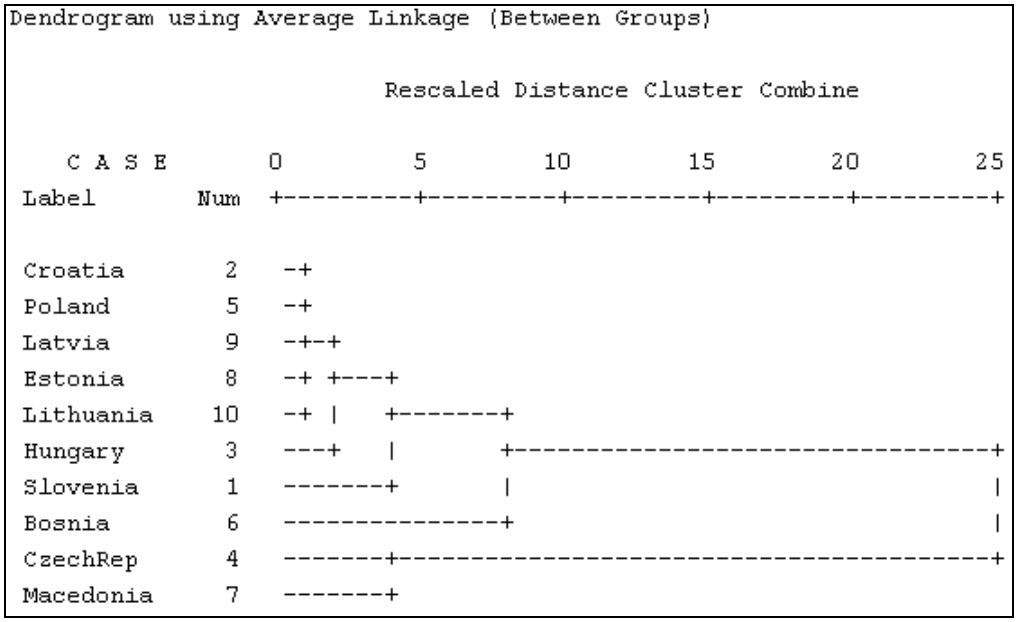
Denrdogram for 2004 is shown in Figure 2. Croatia is most similar to Hungary and Poland. It is shown that Czech Republic and Macedonia are in separate group. This classification is confirmed by k-means method (Table 1). Countries classification for 2008 is shown by dendrogram in Figure 3. Czech Republic and Macedonia are in separate group with Bosnia. Other countries are classified as in 2004. That is confirmed by k-means method (Table 1).

By these methods, countries are classified according to their similarity according to all relevant foreign indebtedness indicators at the same time.



Source: Estimated according to the observed countries National Banks data (2010), IMF (2010)

Figure 2: Dendrogram using average linkage (between groups) according to all indicators in 2004.



Source: Estimated according to the observed countries National Banks data (2010), IMF (2010)

Figure 3: Dendrogram using average linkage (between groups) according to all indicators in 2008.

One-way ANOVA testing the public debt (%GDP) were conducted with respect to countries membership in the EU in 2004 and 2008. The results are shown in Tables 2-3. It can be concluded that there is no statistical difference of the public debt (%GDP) between observed countries regardless of whether they are EU members or not.

Table 2: One-way ANOVA testing the public debt (%GDP) with respect to countries membership in the EU in 2004.

ANOVA

public debt (% GDP)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	,004	1	.004	,161	,699
Within Groups	,215	8	.027		
Total	,219	9			

Source: Estimated according to the observed countries National Banks data (2010), IMF (2010)

Table 3: One-way ANOVA testing the public debt (%GDP) with respect to countries membership in the EU in 2008.

ANOVA

public debt (% GDP)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	,012	1	.012	,310	,593
Within Groups	,322	8	.040		
Total	,335	9			

Source: Estimated according to the observed countries National Banks data (2010), IMF (2010)

4. MULTICRITERIA FOREIGN DEBT ANALYSIS OF THE SELECTED TRANSITION ECONOMIES

4.1. The PROMETHEE Method

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:

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

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 (Brans and Vincke 1985; Brans and Mareschal 1989). 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:

iii. leaving flow:

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

iv. 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).

4.2. Problem Presented by Multicriteria Method

For each criterion, one of the six offered preference function types and its thresholds have been chosen. In this way, the problem was completely prepared for the implementation of the PROMETHEE, as an appropriate method for such a multi-criteria, and relatively weakly structured problem. Its advantages lie in the possibility to define indifference and preference thresholds that have the real economic importance. The choice of the function types, and its thresholds, was carried out in cooperation with the same group of

experts who conducted a detailed analysis of the values of each criterion for all the observed countries. In addition to that, the final ranking is obtained by cumulating mutual comparisons of alternative pairs, according to all the criteria, into final leaving and entering flows, i.e. the final rank of alternatives.

The group of alternatives consists of 9 countries which are compared firstly according to the all criteria (Tomić-Plazibat at al. 2010), the state criteria and finally the flow criteria of foreign indebtedness. It should be noted that Bosnia in its annual statistic reports and bulletins do not show the total foreign debt, but only the public foreign debt and can not be ranked with other selected countries.

Table 4: Types and weights according to all foreign indebtedness indicators.

	S1	S2	S3	T1	T2	Ost
Min/Max	Minimize	Minimize	Maximize	Minimize	Maximize	Maximize
Weight	2.7500	2.2500	1.7500	1.7500	0.7500	0.7500
Preference Functi	Linear	Linear	V-Shape	Linear	Usual	V-Shape
Indiference Thres	0.4800	1.3200	-	0.1000	-	-
Preference Thres	0.8000	2.2000	0.2000	0.2000	-	0.0700

Source: According to authors' analysis

Table 5: Types and weights according to foreign indebtedness state indicators.

	S1	**S2**	S3
Min/Max	Minimize	Minimize	Maximize
Weight	4.0000	3.5000	2.5000
Preference Functi	Linear	Linear	V-Shape
Indiference Thres	0.4800	1.3200	-
Preference Thres	0.8000	2.2000	0.2000
Gaussian Thresh	-	-	-

Source: According to authors' analysis

Table 6: Types and weights according to foreign indebtedness flow indicators.

	T1	T2	Ost
Min/Max	Minimize	Maximize	Maximize
Weight	4.5000	3.5000	2.0000
Preference Functi	Linear	Usual	V-Shape
Indiference Thres	0.1000	-	-
Preference Thres	0.2000	-	0.0700
Gaussian Thresh	-	-	-

Source: According to authors' analysis

The types and weight values of all criteria for 2008 according to relevant criteria are shown in Tables 4 - 6.

4.3. Results

After the analysis has been carried out, the final ranks of alternatives according to the foreign indebtedness indicators are given in Table 7. PROMETHEE II method, taking into account all foreign indebtedness indicators and foreign indebtedness state indicators, shows the Czech Republic lieder position with regard to other countries in the sample. This confirms that the Czech Republic as a country in Central Europe is relatively better managing its foreign debt regardless of its amount.

Table 7: PROMETHEE II complete ranking according to the foreign indebtedness indicators.

ALL FOREIGN INDEBTENESS INDICATORS			FOREIGN INDEBTENESS STATE INDICATORS			FOREIGN INDEBTENESS FLOW INDICATORS		
RANK	ACTION	PHI	RANK	ACTION	PHI	RANK	ACTION	PHI
1.	Czech Rep.	0,46	1.	Czech Rep.	0,45	1.	Macedonia	0,57
2.	Lithuania	0,07	2.	Macedonia	0,35	2.	Czech Rep.	0,49
3.	Macedonia	0,05	3.	Poland	0,20	3.	Hungary	0,23
4.	Hungary	0,04	4.	Lithuania	0,01	4.	Lithuania	0,22
5.	Croatia	0,04	5.	Croatia	-0,00	5.	Croatia	0,06
6.	Poland	-0,01	6.	Hungary	-0,09	6.	Estonia	-0,13
7.	Latvia	-0,14	7.	Estonia	-0,23	7.	Slovenia	-0,36
8.	Slovenia	-0,23	8.	Slovenia	-0,27	8.	Latvia	-0,52
9.	Estonia	-0,28	9.	Latvia	-0,43	9.	Poland	-0,56

Source: Estimated according to the observed countries National Banks data (2010), IMF (2010)

In Table 8 there are Spearman's correlation coefficients between countries ranks according to different group of foreign indebtedness indicators. There is no statistical difference between countries ranks according to all foreign indebtedness indicators and foreign indebtedness state indicators. Spearman's rank correlation for these indicators is significant.

According to foreign indebtedness flow indicators, relative best ranking of Macedonia can be explained by the still low level of involvement in international capital flows. Differences between ranking countries (phi) (Table 7) are higher according to the foreign indebtedness flow indicators in relation to their ranks according to the foreign indebtedness state indicators which show the quality of management of external debt.

Table 8: Spearman's correlation coefficients between countries ranks matrix.

Correlations

			ALL FOREIGN INDEBTEDNESS INDICATORS	FOREIGN INDEBTEDNESS STATE INDICATORS	FOREIGN INDEBTEDNESS FLOW INDICATORS
Spearman's rho	ALL FOREIGN INDEBTEDNESS INDICATORS	Correlation Coefficient	1,000	,783*	,750*
		Sig. (2-tailed)	.	,013	,020
		N	9	9	9
	FOREIGN INDEBTEDNESS STATE INDICATORS	Correlation Coefficient	,783*	1,000	,583
		Sig. (2-tailed)	,013	.	,099
		N	9	9	9
	FOREIGN INDEBTEDNESS FLOW INDICATORS	Correlation Coefficient	,750*	,583	1,000
		Sig. (2-tailed)	,020	,099	.
		N	9	9	9

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

Source: Estimated according to the observed countries National Banks data (2010), IMF (2010)

That indicates statistical non-significance of Spearman's correlation coefficient between countries ranks according to state and flow indebtedness indicators.

5. CONCLUSION

Using the classification and ranking methods for selected transition countries it is determined ranking of countries based on a variety of indicators which provide a better analytical basis of evaluation of the importance of foreign debt. Specifically, the analysis showed the importance of flows of foreign debt indicators for the assessment and debt managing. Differences between countries according to the foreign indebtedness state indicators are less than their difference with respect to the foreign indebtedness flow indicators. This indicates the importance of flow debt indicators in the analysis of foreign debt. This study is primarily a methodological character. By increasing the number of indicators in the further studies, it is expected to achieving the complex results.

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