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TRADE PATTERNS IN CROATIA: K-MEANS CLUSTER ANALYSIS

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Summary

This paper aims at contributing to a better understanding of trade patterns in Croatia. The work is oriented toward the role and contribution of individual product groups in total Croatian trade patterns. K-means cluster analysis is conducted with the RCA indicator, GL index and RUV indicator as variables and product groups at the three-digit level of the Standard International Trade Classification (SITC) as objects. Three different clusters of product groups are identified with statistically significant differences in values of analyzed variables. Implications of generated clusters of product groups are discussed. Product groups with the highest utility in international trade are identified for Croatia.

***Keywords**: trade patterns, intra-industry specialization, comparative advantages, Croatia*

1. INTRODUCTION

The changes in trade patterns of transition economies were very interesting for empirical research during the last few years (Kierzkowski 1998; Havlik, Landesmann and Stehrer 2001; Kaminski, and Ng 2001; Kandogan 2003; Gligorov and Vidovic 2004; Kaitila 2004). Trade structures are usually identified as an inter-industry or an intra-industry type. Inter-industry trade occurs when countries export and import products from different industries. Intra-industry

trade is defined as the simultaneous export and import of products which belong to the same sector Vollrath (1991). Intra-industry trade could be divided into two significantly different categories. Horizontal intra-industry trade occurs when similar products are simultaneously exported and imported, mainly due to product differentiation. Vertical intra-industry trade represents the simultaneous exports and imports of goods within one industry but the products are at different stages of production.

Intra-industry trade can be separated into horizontal and vertical types based on the unit value of exports and imports (Algieri 2004; Reganati and Pittiglio 2005). The unit value of exports is calculated as the value of exports divided by the quantity and unit value of imports as the value of imports divided by the import quantity. If RUV is within the interval 0.85- 1.15 intra-industry trade is horizontal, conversely if it is outside of this interval it is vertical.

Empirical research of intra-industry trade began in the mid 1960s. The first results were exposed by Balassa (1966). The most well known work on intra-industry trade was made by Grubel and Lloyd (1975). This research was then followed by, what we know as today as, the theory of intra-industry trade (Dixit and Stiglitz 1977; Krugman 1980, 1981; Lancaster 1980; Helpman 1981). The role and significance of intra-industry trade in the process of globalization and integration of transition economies on international markets is becoming more important than previously. Research in the field of international trade shows that intra-industry is the fastest growing segment in the international trade of transition economies (Aturupane, Djankov and Hoekman 1997; Kaminski 2001). The key question is what happens with the comparative advantages and utility in international trade. Namely, we can ask does an increase in the integration with international markets and growth in intra-industry trade specialization correspond to the changes in comparative advantages towards higher value added products.

The purpose of this paper is to identify the cluster of product groups, in which Croatia has the greatest utility in international trade. That is why interdependence between intra-industry trade specialization, comparative advantages and unit value of export and import has been analyzed. The analyses were made by applying k-means cluster analyses.

The basic hypothesis of this paper is that the cluster of product groups, in which Croatia shows the greatest utility in international trade, has the lowest share in trade patterns compared to other clusters.

The paper is divided into four parts: introduction, methodology, empirical results and conclusion.

2. METHODOLOGY

The data are at the 3-digit level according to the SITC (Standard International Trade Classification) and includes 246 product groups. The analysis is conducted using the data for 2004. The data are sourced from the Croatian Bureau of Statistics.

The empirical analysis of the trade pattern in Croatia was calculated using the following indicators:

- "Grubel-Lloyd Index", GL index;
- "Relative Unit Value" (RUV indicator);
- "Revealed Comparative Advantages" (RCA indicator).

The GL index shows the level of intra-industry trade specialization. The methodologies and calculations of the GL index were developed and applied by Grubel and Lloyd (1975).[1] For individual product groups the GL index is calculated using the formula:

$$GLi = \frac{\sum_{i=1}^{n}(X_i + M_i) - \sum_{i=1}^{n}|X_i - M_i|}{\sum_{i=1}^{n}(X_i + M_i)} * 100$$

GL_i is the value of the Grubel-Lloyd index for product group *i*. X is defined as the value of exports, and M is the value of imports. The coefficient can vary from 0 to 1. The closer it is to 1, the higher the degree of specialization in intra-industry trade. A lower value of the coefficient shows that the country has a higher level of specialization in inter-industry trade.

The RUV indicator was originally developed by Abd-el-Rahman (1991). Later, numerous derivations originated from this indicator (Greenawy, Hine and Milner 1994, 1995). The RUV indicator is useful for the purpose of analyses of horizontal and vertical intra-industry trade. The indicator is based on the unit value of exports and imports. The unit value of exports is calculated as the value of exports divided by the quantity and the unit value of imports as the value of imports divided by the import quantity:

$$1 - \alpha \leq \frac{UVX_i}{UVM_i} \leq 1 + \alpha$$

UVX_i refers to the unit value of exports of product groups *i*, and UVM_i refers to the unit value of imports. Parameter α is a dispersion factor. The value of the

[1] See more details about the use of index of intra-industry trade specialization in transition economies in Kaminski and Ng (2001).

parameter can be arbitrarily fixed. In most studies the parameter is assumed to be equal to 0.15 (Algieri 2004; Reganati and Pittiglio 2005). If the exports and imports unit value differ by less than 15%, then intra-industry trade is horizontal, and if the difference is higher, intra-industry trade is vertical. If the RUV is within the interval (0.85; 1.15) intra-industry trade is horizontal; conversely if it is outside of this interval it is vertical. If the RUV is greater than 1.15, the country is "exporting quality" while if it is smaller than 0.85 the country is "importing quality".

The methodology for calculating the RCA indicator was originally developed by Bela Balassa (1965). Later, numerous derivations originated from this indicator. The RCA indicator is useful for the purpose of comparing comparative advantages for individual product groups[2]. The RCA indicator is calculated by the formula:

$$RCA = \ln\left[\frac{X_i}{M_i}\right] \times \left(\frac{\sum_{i=1}^{n} X_i}{\sum_{i=1}^{n} M_i}\right) \times 100$$

X is defined as the value of exports, while M is the value of imports. Index i is the product group classified according to SITC. A positive value indicates that the country has comparative advantages in the corresponding product group. Conversely, a negative sign for the RCA indicator implies that there are no comparative advantages.[3] An alternative for RCA indicators is the Lafay's RCA index. Compared to Balassa's RCA indicator, Lafay's index takes in regard the flows of trade inside each sector of the economy, GDP as well as exports and imports for each group of products.[4]
Besides Balassa's RCA indicator and Lafay's index, the export structure can be analyzed by using the CEP (Comparative Export Performance) indicator.[5]

By applying k-means cluster analysis, the RCA indicator, the GL index and the RUV indicator are analyzed. In general, k-means clustering procedure can be understood as ANOVA in reverse. Analyzed objects (products at the three-digit level of SITC) are moved in and out of clusters until the most significant ANOVA results are achieved. As an indicator of how well the respective variable discriminates between clusters, the magnitude of the F values is used.

[2] See more details about the use of RCA indicator in Balassa (1965), Lafay (1992), and for transition economies Kaminski and Ng (2001), Yilmaz (2003).
[3] In analyzing the trade structure in transition countries using RCA indicators, see for example in Djankov and Hoekman (1997), Kaminski and Ng (2001), Yilmaz (2003).
[4] See more details about the use of Lafay's index in Lafay (1992).
[5] See more details about the use of CEP indicator in Donges (1982).

In k-means cluster analysis statistically generated cluster centers are computed by procedures in which objects are firstly organized according to the distance between themselves. After that, k number of cluster centers are chosen in order to classify all objects in k number of clusters (k is a predetermined number of clusters). Objects are assigned to particular clusters according to their distance from particular cluster centers. The procedure is repeated until cluster centers are found that allow classification of all objects in k number of clusters with the most significant ANOVA results.

In k-means cluster analysis distances between objects and between objects and cluster centers are measured by unscaled squared Euclidean distances. For example, the distance D(i,k) of an object i from cluster center k for M analyzed variables X_j is calculated as follows:

$$D(i,k) = \sqrt{\frac{1}{M}\sum_{j=1}^{M}\left(X_{ij} - \overline{X}_j^{(k)}\right)^2}$$

where $\overline{X}_j^{(k)}$ is the mean value of variable j for cluster k.

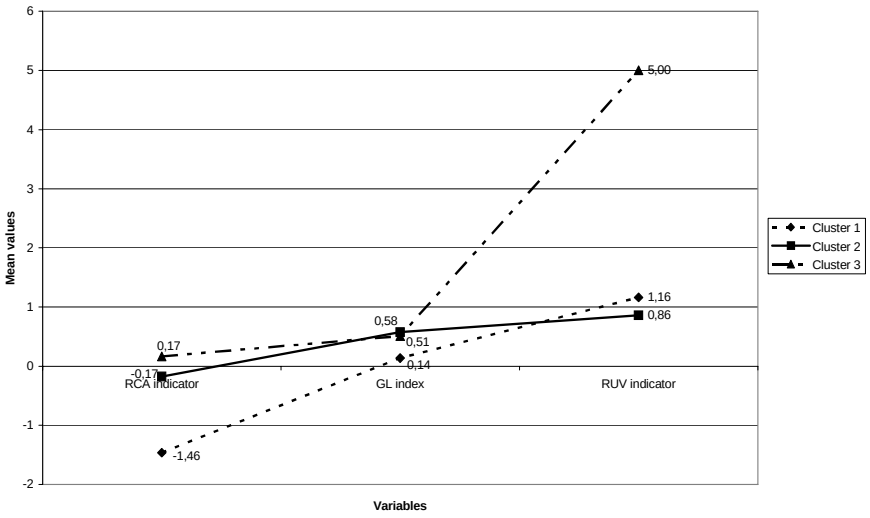
Values X_j are not rescaled in any way, therefore distances between objects and between objects and cluster centers are expressed in measurement units of analyzed variables.

3. EMPIRICAL RESULTS

K-means cluster analysis was used to identify the existence of different clusters of product groups in Croatia relative to their intra-industry trade specialization and comparative advantages in order to explore interdependence between those concepts. Values for the RCA indicator, the GL index and the RUV indicator are used as inputs in k-means cluster analysis. Product groups at the three-digit level according to the Standard international trade classification (SITC) represent objects of clustering.

The results of the k-means cluster analysis indicate that in Croatia three different clusters of product groups exist relative to the values of the analyzed variables. The best generated solution is with three clusters. Generated clusters represent product groups that are maximally homogeneous within each cluster, and maximally heterogeneous between clusters. Graph 1 shows mean values for the RCA indicator, the GL index and the RUV indicator for generated clusters.

Graph 1 – Plot of Means for Each Cluster



ANOVA procedures found there were significant differences among three generated clusters of products groups on all three analyzed variables (Table 1). These results indicate that product groups are maximally homogeneous within each cluster and maximally heterogeneous between clusters.

Table 1

Analysis of Variance

Variable	Between SS	df	Within SS	df	F	p-value
RCA indicator	96.7380	2	98.3025	243	119.5663	0.0000
GL index	10.9417	2	9.8332	243	135.1967	0.0000
RUV indicator	287.2311	2	135.0766	243	258.3615	0.0000

The following table shows Euclidean distances and squared Euclidean distances between generated clusters. Note that clusters 1 and 2 are relatively close together (Euclidean distance = 0.80) relative to the distance of cluster 3 from clusters 1 and 2.

Table 2

Euclidean distances between clusters (squared distances above diagonal)

Cluster Number	No. 1	No. 2	No. 3
No. 1	0.0000	0.6474	5.4514
No. 2	0.8046	0.0000	5.7255
No. 3	2.3348	2.3928	0.0000

Concerning the number of product groups, cluster 2 is the biggest and contains 122 products. Cluster 3, which includes 19 products, is the smallest. Cluster 1 has 99 products.

Cluster 1 has no comparative advantages. In this cluster is a high level of inter-industry trade specialization. Also, there are little utilities in trade concerning the value of the RUV indicator (Graph 1). A significant impact on the empirical results in cluster 1 is in the automobile industry in which Croatia has no comparative advantages, inter-industry specialization is dominant and the ratio between the unit value of export and import is very small (RUV). This is a consequence of the considerable growth in the value of imports of road vehicles relative to exports during the transition period. Compared to Croatia, other developed transition economies like the Czech Republic, Hungary and Slovakia, have the highest level of intra-industry trade specialization in the automobile industry, as well as, strong comparative advantages (Buturac, Lovrinčević and Teodorović 2004). This is primarily the result of foreign direct investments, which have strong impacts on efficient restructuring and the rapid development of this segment of the economy.

Although cluster 2, also has no comparative advantages, the RCA indicator is considerably better than for cluster 1. Compared to cluster 1, cluster 2 shows a higher level of intra-industry trade specialization. Cluster 2 contains a shipbuilding industry, which is not typical for the trade patterns in other transition economies, and has the highest share in Croatian exports of goods, 13.5%. As a cluster as a whole, the shipbuilding industry shows a higher level of intra-industry specialization than in inter-industry, as well as little utility in trade concerning the values of the RCA and RUV indicators.

Cluster 3 has approximately the same level of intra-industry and inter-industry trade specialization. Compared to cluster 1 and 2, only cluster 3 has comparative advantages. Also, this cluster has the highest value for the RUV indicator, i.e., the unit value of exports is considerable higher than unit value of imports. The values of the RCA, GL and RUV indicators for the individual clusters indicate that the cluster records the highest utility in trade compared to clusters 1 and 2. Concerning the number of product groups, cluster 3 has a share of 7.7%. Also, products in cluster 3 have a share of total exports of 11.5% and 5.8% of total imports. These results confirm the basic hypothesis that the cluster

of product groups, in which Croatia shows the greatest utility in international trade, has the lowest share in trade patterns compared to other clusters. Concerning products in cluster 3 we can conclude that Croatia has the highest utility in trade with tobacco products, pharmaceutical products, textile products and fish products. The alignments of fish products in cluster 3 are not typical for the Croatian food industry. Namely, the great majority of food products are in clusters 1 and 2 in which there are no comparative advantages. The loss in comparative advantages of Croatian food industry in the last few years is the consequence of a higher level of liberalization in domestic markets and significant growth in the value of imports of food products, and at the same time stagnating exports.

The empirical results show that cluster 1 which has the highest level of inter-industry trade specialization, has no comparative advantages, and has the lowest value of the RCA indicator compared to clusters 1 and 2. At the same time, cluster 2, which has the highest level in intra-industry trade specialization, has no comparative advantages, similar to cluster 1. Also, cluster 2 has the lowest value of the RUV indicator. The highest utility in trade, using the values of the RCA and RUV indicators, are in cluster 3 which has approximately the same level of intra-industry and inter-industry trade specialization. These empirical results for Croatia indicate that higher or lower utility in trade does not depend on the level of intra-industry and inter-industry trade specialization. The analyses of three clusters shows low level intra-industry trade specialization in Croatia. This is not typical for transition economies which have already accessed to the EU. Namely, the empirical research for these transition economies showed that the growth in intra-industry trade specialization has a positive result on changing comparative advantages towards higher value added products (Buturac 2005).

The growth of intra-industry specialization in transition economies is primarily the result of foreign direct investments which restructured some economic sectors. This is especially dominant in the automobile industry. Also, there is a positive correlation between intra-industry specialization and comparative advantages, which are not evident for Croatia. Foreign direct investments in Croatia did not contribute to the growth in intra-industry specialization, or in the significant improvement in comparative advantages. Most investments in Croatia were directed toward the domestic market i.e. monopoly or oligopoly positions (Buturac 2005).

4. CONCLUSION

The k-means cluster analysis indicates that in Croatia three different clusters of product groups exist relative to values of analyzed variables. The best obtained result is with three clusters. The cluster of product groups, in which Croatia shows the greatest utility in international trade with respect to the RCA and RUV indicator, has the lowest share in trade patterns compared to other

clusters. Croatia has the highest utility in trade with tobacco products, pharmaceutical products, textile products and fish products. The analyses of three clusters refer to low level intra-industry trade specialization in Croatia. The empirical results for Croatia indicate that the level in intra-industry and inter-industry trade specialization does not have an influence on the improvement of trade patterns. This is not typical for transition economies which have already accessed to the EU.

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STRUKTURA MEĐUNARODNE ROBNE RAZMJENE U HRVATSKOJ: K-MEANS CLUSTER ANALIZA

Sažetak

Cilj rada je doprinijeti boljem razumijevanju strukture međunarodne robne razmjene u Hrvatskoj. Rad je orijentiran prema spoznavanju uloge i doprinosa pojedinih grupa proizvoda u ukupnoj strukturi međunarodne razmjene Hrvatske. Podaci su analizirani k-means cluster metodom, pri čemu su RCA pokazatelj, GL indeks i RUV pokazatelj varijable, dok su objekti analize proizvodne grupe na razini tri znamenke SMTK. Identificirana su tri različita clustera proizvodnih grupa sa statistički značajnim razlikama u vrijednostima analiziranih varijabli. Razmatrane su implikacije generiranih clustera proizvodnih grupa. Identificirane su proizvodne grupe razmjenom kojih Hrvatska ostvaruje najveće koristi u međunarodnoj razmjeni.

Ključne riječi: struktura međunarodne robne razmjene, intra-industrijska specijalizacija, komparativne prednosti, Hrvatska

JEL classification: F19