

Leonid Raneta<sup>1</sup>, Mykhaylo Kunychka<sup>2</sup>

## APPLYING CLUSTER ANALYSIS TO STUDYING COMMERCIAL DIPLOMACY OF UKRAINE \*

*The main purpose of this paper is to verify the relationship between commercial diplomacy of Ukraine and export flows, for which the two statistical methods have been used: simple regression analysis and the combination of simple regression and cluster analysis. As commercial diplomacy actors the staff of diplomatic missions abroad is considered. A positive relationship between the staff of diplomatic missions of Ukraine and export flows is found. It has also been revealed that this effect varies subject to the groups of the countries targeted.*

*Keywords:* cluster analysis; regression analysis; commercial diplomacy; foreign trade; Ukraine.

Леонід Ранета, Михайло Кунічка

## ЗАСТОСУВАННЯ КЛАСТЕРНОГО АНАЛІЗУ ДО ДОСЛІДЖЕННЯ ЕКОНОМІЧНОЇ ДИПЛОМАТІЇ УКРАЇНИ

*У статті перевірено взаємозв'язок між економічною дипломатією України та експортом. Для цього використано два статистичних методи: лінійний регресійний аналіз і поєднання регресійного та кластерного аналізу. Суб'єктами економічної дипломатії вважаємо працівників дипломатичних місій за кордоном. Виявлено позитивний зв'язок між персоналом дипломатичних представництв України та експортними потоками. Доведено, що цей ефект варіюється залежно від груп країн, які досліджуються.*

*Ключові слова:* кластерний аналіз; регресійний аналіз; економічна дипломатія; зовнішня торгівля; Україна.

*Форм. 4. Рис. 4. Табл. 3. Літ. 10.*

Леонид Ранета, Михаил Куничка

## ПРИМЕНЕНИЕ КЛАСТЕРНОГО АНАЛИЗА В ИССЛЕДОВАНИИ ЭКОНОМИЧЕСКОЙ ДИПЛОМАТИИ УКРАИНЫ

*В статье проверена взаимосвязь между экономической дипломатией Украины и экспортными потоками. Для этого использованы два статистических метода: простой регрессионный анализ и сочетание простого регрессионного и кластерного анализа. Дипломатические миссии за рубежом рассмотрены как субъекты экономической дипломатии. Выявлена положительная взаимосвязь между персоналом дипломатических представительств Украины и экспортом. Доказано, что этот эффект варьируется в зависимости от исследуемых групп стран.*

*Ключевые слова:* кластерный анализ; регрессионный анализ; экономическая дипломатия; внешняя торговля; Украина.

**Introduction.** Nowadays, countries are facing external pressure from the global economic and trade systems and emerging highly competitive economies are not the exception. Therefore, in the last decades, the issue of protection of national economic and commercial interests of individual states becomes more and more relevant. An important role in achieving this objective is attained to state instruments supporting home business activities, including commercial diplomacy.

Currently there is no consensus on the definition of commercial diplomacy, which can be explained by the consequence of the uneven development of this phe-

<sup>1</sup> University of Economics in Bratislava, Slovakia.

<sup>2</sup> University of Economics in Bratislava, Slovakia.

\* This article has been elaborated within the project VEGA no. 1/1326/12, "Neoregionalizacia svetovej ekonomiky a spolocnosti", supervisor: Ladislav Lysak.

nomenon in different countries and regions of the world. In this article we use the definition by Saner and Yiu. These authors define it as "work of diplomatic missions in support of the home country's general objective of national development" (Saner and Yiu, 2003). In addition, Saner and Yiu suggests that "important aspects of a commercial diplomats' work is supplying information about export and investment opportunities and organization and helping to act as host to trade missions from home». Due to accuracy of this definition and its widespread use, the authors will comply with its contents in the following sections.

The essence of commercial diplomacy is represented through its roles and functions. For example, E. Pajtinka (2007) identifies the following functions of commercial diplomacy: promotion and development of trade relations, investment promotion, information function, political and legislative function, development assistance and state promotion. In this paper we discuss the function of promoting and developing trade relations which is in scientific literature sometimes indicated as export promotion.

The ambition of this paper is to verify the systematic relationship between Ukrainian export flows and diplomatic representation abroad, respectively the number of staff of Ukrainian embassies. Our dataset researched 78 export destinations (95% of the total country's export) of during the year 2012.

**Background.** The group of the most prominent foreign experts on commercial diplomacy includes Van Veenstra, Yakop and Van Bergeijk (2010), Rose (2007) and others. The abovementioned authors discuss the issue whether embassies are related to export activities in the context of commercial diplomacy effectiveness. Rose (2007) has concluded that there is a statistical relationship between the presence of diplomatic offices and export flows. Rose's statistical analysis shows that additional diplomatic representation in a host country leads to an increase in exports by 6 to 10%. Van Veenstra, Yakop and Van Bergeijk (2010) are the other authors dealing with the influence of foreign missions on export flows. These authors have studied the group of 36 states in 2006 and concluded that 10% increase in the number of embassies and consulates lead to 0.5–0.9% increase in export flows.

**Methodology and data.** For analyzing the impact of diplomatic missions of Ukraine on export flows we use two statistical methods. We apply simple regression analysis on the basis of ordinary least squares method (OLS) and a combination of simple regression and cluster analysis.

Regression analysis can be defined as the form of relationship in which the variable change depends on the impact of one or more factor variables. The main task of regression analysis is to evaluate the functional dependence of the conditional means of the dependent variable from the independent variable. In this paper we use the simple regression analysis based on a linear model that can be presented in the form of a linear equation:

$$Y_t = \beta_1 + \beta_2 X_t + e_t, \quad (1)$$

where  $Y$  is the dependent variable;  $X$  stands for the independent variable;  $\beta_1$  a  $\beta_2$  are the parameters examined;  $t$  stands for the examined period;  $e$  is the statistical error.

In our case the referred linear model explains the interaction between the number of employees of Ukrainian embassies abroad and Ukrainian export of goods and

services, while the share of exports is dependent variable ( $Y$ ) and the share of employees of embassies is an independent variable ( $X$ ). Through simple regression we examine the export of Ukraine to countries with diplomatic missions.

The analysis excludes all export destinations that do not have official diplomatic missions of Ukraine. In some countries, Ukraine is not directly (physically) represented, but there official representation in the neighboring countries, what is mainly caused by a limited budget of the Ministry of Foreign Affairs (MFA). Data on export to particular countries, which do not have official missions have also been omitted because of the undesirable affect on the results. The data on permanent missions to international organizations and the data on the number of their staff were also omitted because of the estimation bias effect. Current analysis also omits data on joint diplomatic missions. Joint missions are allowed to realize their duties and functions in accordance with the regulations of several countries (Mattos, 2014). The inclusion of these missions into the analysis could have also distorted the regression output.

In addition to the abovementioned simple regression, we use cluster analysis. Cluster analysis is applied when it is necessary to set up a large number of data into smaller groups (clusters). These clusters will encompass all values with the biggest similarity. Such a classification allows us assess and understand the relationships between large amounts of data (Repkine, 2012). According to Repkine, cluster analysis is a multidimensional statistical procedure, which collects data on an object and then arranges objects into relatively homogeneous groups. Using cluster analysis it is possible to set up the group of states in a smaller number of clusters that can be further studied. In this paper, by means of SG Centurion (statistical software) we disaggregate 78 export destinations of Ukraine into 3 groups (clusters), what allow us alleviate the occurred extremes. Although 78 countries are not a complete list of export destinations of Ukraine, they represent 95% of the total exports of this country. We consider this share as a sufficient amount for carrying out regression analysis. For cluster analysis we used the squared Euclidean distance and as type of clustering we chose Ward's clustering method (Ward, 1963).

Individual data for analysis of the relationship between the export flows of Ukraine and the number of diplomatic employees were obtained from the official websites of Ukrainian government. Data on the number of embassies staff have been drawn by time-consuming method of counting from the official website of the Ministry of Foreign Affairs of Ukraine and various embassies (Ministry of Foreign Affairs, 2012). Comprehensive and up to date information concerning exports of goods and services during 2012 were obtained from the official website of the State Statistical Service of Ukraine (State Statistical Service, 2014). In present analysis we use the absolute value of exports (expressed in USD), which were converted to relative values (the share of each country in the total exports of Ukraine). The absolute number of diplomatic missions staff of Ukraine (expressed in persons) was also converted to relative values.

The share of export to individual country in the total export ( $X_{uj}$ ) and the share of embassies employees in individual states in the total number of employees of diplomatic missions ( $E_{uj}$ ) was calculated using the following equations:

$$X_{uj} = \frac{X_j}{X_t}, \quad (2)$$

where  $X_j$  is the volume of export of Ukrainian goods and services to country  $j$ ;  $X_t$  is the total volume of exports of Ukraine in the studied group of countries during the period  $t$ ;

$$E_{uj} = \frac{E_j}{E_t}, \quad (3)$$

where  $E_j$  is the number of employees of diplomatic missions of Ukraine in the country  $j$ ;  $E_t$  is the total number of Ukrainian embassies in all studied countries during the period  $t$ .

**Results and discussion.** The data were processed using statistical software SG Centurion X. The results received can be seen in Table 1. The linear model describes the relationship between the share of exports of goods and services, which is the dependent variable, and the share of diplomatic staff – the independent variable. The formula of the model with the received coefficients has the following form:

$$Y_{uj} = -0.0435864 + 1.29217e_{uj}. \quad (4)$$

The statistical significance of the model can be seen in Table 1. Since the P-value of the model was less than 0.05 ( $P = 0.0075$ ) it could be said that the importance of relationship between the two variables under study is relevant. The coefficient of determination indicates that the model explains only 9.04272% of the variance between the researched variables. The correlation coefficient was positive and equaled to 0.300711. The residual standard deviation was 0.030894, indicating the impact on the dependent variable could be from 0.27 to 0.3316. The above model parameters show that between the dependent and the independent variables there is a statistically significant relationship, but the proportion of employees of the Embassy explains only a small part of the share of exports of goods and services due to several extremes which will be analyzed below.

Table 1. Regression analysis results

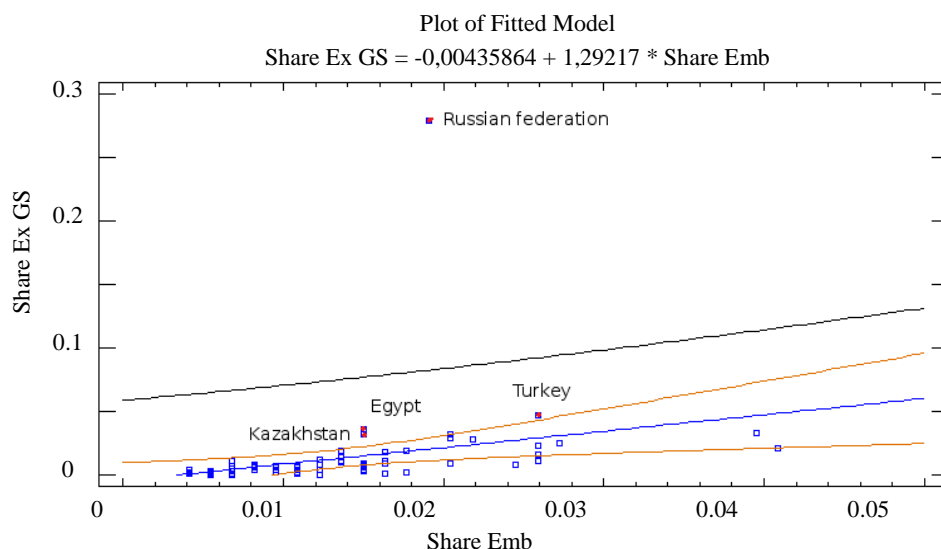
Model	$\beta_2$	Correlation coefficient	$R^2$	SD	P-value
$Y_t = \beta_1 + \beta_2 X_t + e_t$	1.29217	0.300711	9.04272	0.030894	0.0075

Source: authors' calculations in SG Centurion XVI.

The scatterplot of our data can be seen in Figure 1. On the scatterplot we can see that the regression analysis had to deal with several statistical extremes that reduce the coefficient of determination, and increase the standard deviation of the model. These extremes (in lighter colour) express a relatively large share on exports from Ukraine and a relatively small proportion of Ukrainian diplomatic staff. The most extreme observations are the Russian Federation, because it is the largest export destination of Ukraine (27.9% of the total exports), but the Ukrainian Embassy in Russia hires a relatively small number of staff (14 people, or 1.91% of the total number of embassies' employees abroad). The other example is Moldova where Ukrainian Embassy had 19 workers (2.6% of the total number of Ukrainian diplomatic staff), on the other hand, exports to that country represents only 1.09% of the total exports of goods and services.

The output of the regression analysis allows us graphically analyze the data with representation of median, predictive intervals and confidence intervals (Figure 1). As

we mentioned at the beginning of this paper, economic diplomacy aims to promote exports of home country, which means it intensifies activities in the priority countries, therefore, Ukraine increases the proportion of employees of its embassies. In this context, the political interpretation of our model is that all states placed above the median are stronger trading partners and less prioritized in terms of Ukrainian diplomacy, because Ukraine was represented with a relatively small number of staff at the Embassy. On the other hand, the states below the median in our model in terms of economic diplomacy are promising, therefore, the economic diplomacy concentrated its activities there.



Source: authors' calculations in SG Centurion XVI.

Figure 1. Scatterplot of regression analysis of the whole dataset

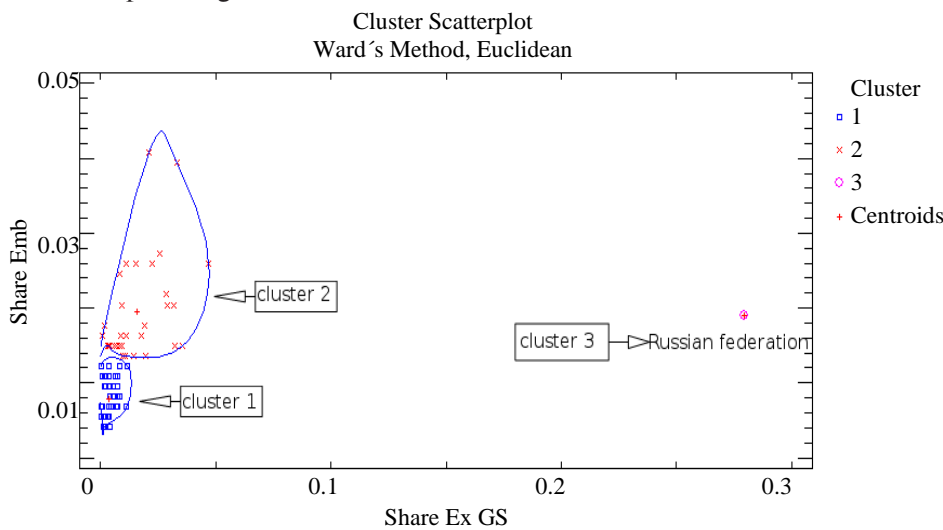
The research has shown that the dataset included a number of significant extremes. Their occurrence encouraged the authors of this paper to use cluster analysis, which should ease the existing extremes. Cluster analysis allowed grouping the states by the similarity of parameters.

The selected 78 countries, which were both export destinations of Ukraine and had functioning embassies, were statistically divided into 3 clusters (Figure 2). Each of these 3 clusters is a group of countries with similar characteristics. These groups of countries were created using the smallest distance principle.

After the division into clusters regression analysis had been executed inside each cluster, with the exception of Cluster 3, because it had only one observation: Russian Federation.

After simple regression analysis was applied to Cluster 1, authors obtained the results shown in Table 2. It is possible to see that P-value of the model equaled to 0.0201 which is less than 0.05 and which explains the statistical significance of the linear model for Cluster 1. The determination coefficient indicates that the model explains only 11.9424% of the variance share of exports of goods and services in Cluster 1, but we have to mention that it has higher value in comparison to the whole dataset. The correlation coefficient is equal to 0.345578 indicating a positive rela-

relationship between variables (also higher than in the case of the whole dataset). Residual standard deviation represents 0.00288449. We can say that in Cluster 1 between the dependent and independent variables, there is a positive statistical relationship, but the proportion of Embassy employees explains only a small part of the share of exports of goods and services.



Source: authors' calculations in SG Centurion XVI.

Figure 2. Scatterplot of the whole dataset cluster analysis

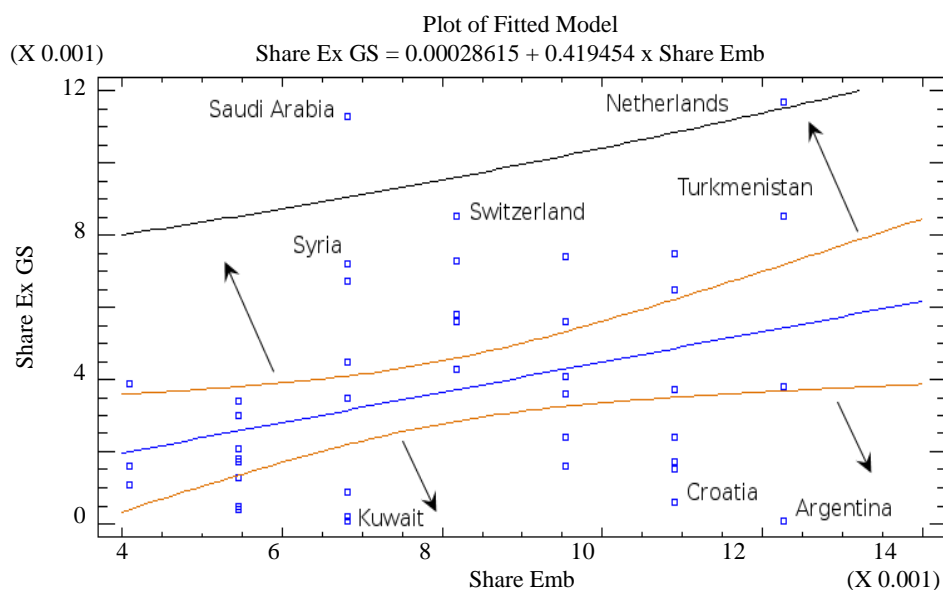
Table 2. Regression analysis results for Cluster 1

Model	$\beta_2$	Correlation coefficient	$R^2$	SD	P-value
$Y_t = \beta_1 + \beta_2 X_t + e_t$	0.419454	0.345578	11.9424	0.00288	0.0201

Source: authors' calculations in SG Centurion XVI.

The regression analysis of Cluster 1 included 45 observations (about 58%) of the monitored countries. Also visual analysis showed that the common characteristic of Cluster 1 was that these countries received a relatively small percentage of Ukrainian exports concurrently with a weak diplomatic representation. Figure 2 shows that the extremes were divided between the clusters forming homogeneous groups. Extremes within Cluster 1 were Saudi Arabia and the Netherlands (9 workers in the Netherlands and 5 in Saudi Arabia).

Visual analysis of Figure 3 (the output of the regression analysis) proves that in Cluster 1 countries placed above the median of the model, could be identified as more important export partners. The countries placed below the median could be regarded as more important in terms of diplomatic offices. Also Figure 3 pointed out such extremes as Argentina and Croatia, where the ministry had set up relatively large representative offices (in terms of employees number) as compared with export flows. Thus, it can be concluded that Ministry of Foreign Affairs of Ukraine gave more priority to those countries, probably because of non-economical aims in those countries. There is a different situation with the countries like the Netherlands, Switzerland and Saudi Arabia which received relatively larger amount of Ukrainian exports.



Source: authors' calculations in SG Centurion XVI.

Figure 3. Scatterplot of regression analysis Cluster 1

Table 3 contains the results of the regression analysis, carried out within Cluster 2. When the simple regression analysis was applied to Cluster 2, we had received the following results: the P-value equaled to 0.0121, that is, less than 0.05, indicating statistical significance of the model. The determination coefficient indicated that the model explained 19.226% of the variance share of exports of goods and services Cluster 2 (twice times higher than in Cluster 1). The correlation coefficient equaled to 0.438475, indicating a relatively stronger positive relationship between the variables, also suggesting much better relationship variables as we could see in the previous regression analysis (the whole dataset and Cluster 1). Residual standard deviation represented 0.0106755. It can be said that Cluster 2 had statistically significant relationship, and it is much stronger than for Cluster 1. These findings allowed us conclude that the countries from Cluster 2 have a better probability for a positive reaction on Ukrainian exports in case of commercial diplomacy intensification.

Table 3. Regression analysis results for Cluster 2

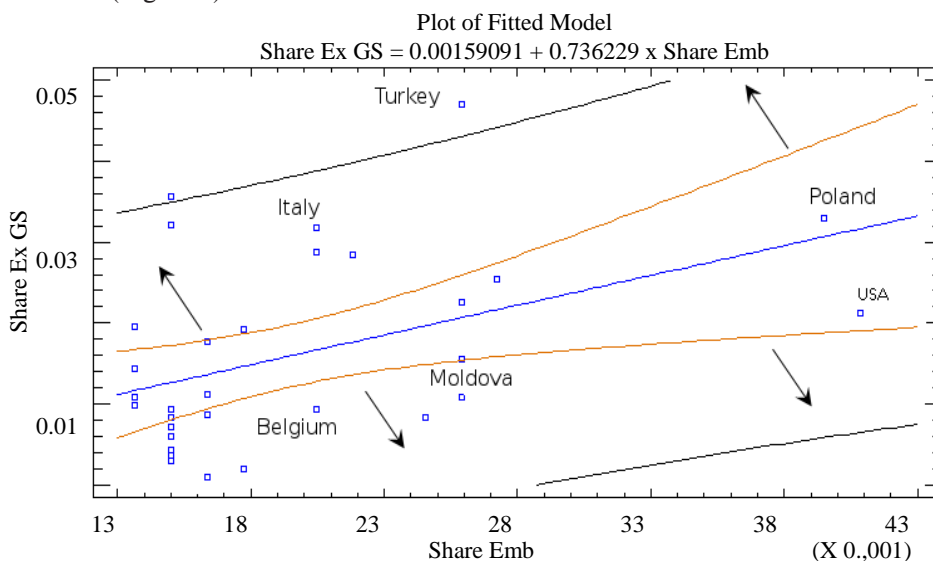
Model	$\beta_2$	Correlation coefficient	$R^2$	SD	P-value
$Y_t = \beta_1 + \beta_2 X_t + e_t$	0.736229	0.438475	19.226	0.0106755	0.0121

Source: authors' calculations in SG Centurion XVI.

Regression analysis of Cluster 2 included 32 observations (41% of the dataset). Based on cluster analysis it can be concluded that Cluster 2 included the countries where the number of embassies employees is relatively high (at least 10 diplomats, for example, in as Azerbaijan, Iran, Iraq, and more than 30 diplomats in the US) and export from Ukraine was relatively high. It should be emphasized that a large number of employees of the Embassy of Ukraine in the United States is explained not only by strong economic and trade relations between them, but also by intensive political

relations. Based on Figure 4, it can be stated that Cluster 2 had some extremes. Extremes for Cluster 2 were such countries as Turkey, Egypt and Kazakhstan. In the case of Turkey can be said that it is an important business partner, a very important export market for Ukraine. The share of Ukrainian exports to Turkey represents 4.7% of the total exports. It should also be said that the number of diplomats of the Embassy of Ukraine in Turkey is 19 people (2.6% of all embassies employees), which is quite high in comparison with other embassies.

Kazakhstan is a specific case. Kazakhstan received 3.2% of Ukrainian exports and the number of diplomats working at the Embassy was only 11 people (1.5% of the total number). This phenomenon can be explained by the participation of both countries in the Commonwealth of Independent States (CIS), therefore these economies had stable economic and trade relations from the times of the USSR, therefore, Ukrainian government does not need to maintain a large number of diplomats at the Embassy in Kazakhstan for further development of political, economic and other relations (Figure 4).



Source: authors' calculations in SG Centurion XVI.

Figure 4. Scatterplot of regression analysis, Cluster 2

A special cluster was represented by a single observation: Russian Federation. Isolation of Russia in Cluster 3 (see Figures 1 and 2) was conditioned by a large share of Ukrainian exports (about 28% of the total Ukraine's exports) and the relatively small number of staff of the Embassy (14 people). Close industrial links and cooperation between Ukrainian and Russian production units in 2012 placed Russian Federation at the first place among Ukrainian export destinations.

**Conclusion.** On the basis of our analysis we can conclude about rather mixed findings. On the one hand, our statistical analysis showed that diplomatic staff and the volumes of Ukrainian exports have statistically positive relationship, according to correlation coefficients and P-values. At the same time, we must admit that this relationship has proved to be relatively weak according to determination coefficients. In order to improve our results cluster analysis was used with the intention to ease the



influence of the outliers. We grouped our observations into 3 clusters. This method proved to be useful as it divided our dataset into homogeneous groups thus creating better conditions for carrying out regression analysis. Our results for Cluster 1 suggest that 10% increase in the share of diplomatic staff will lead to a 4.2% increase in export flows. Equivalent increase of the share of diplomatic staff in Cluster 2 will lead to a 7.4% increase of exports. The empirical findings can be used by the Ministry of Foreign Affairs of Ukraine in order to improve its diplomatic network and their export promotion policies.

**References:**

- Mattos, B.* (2014). K niektorým aspektom vytvarania spoločných zastupiteľských uradov v kontexte najnovšieho vyvoja medzinarodných vzťahov. *Medzinarodne vzťahy*, 12(2): 176–186.
- Ministry of Foreign Affairs of Ukraine (2012). Diplomatic missions of Ukraine // [www.mfa.gov.ua](http://www.mfa.gov.ua).
- Pajtinka, E.* (2007). Hospodarska diplomacia a jej uloha v 21. storočí. *Mezinarodni vzťahy*, 42(4): 52–72.
- Repkine, A.* (2012). How Similar Are the East Asian Economies? A Cluster Analysis Perspective on Economic Cooperation in the Region. *Journal of International and Area Studies*, 19(1): 27–44.
- Rose, A.K.* (2007). The Foreign Service and Foreign Trade: Embassies as Export Promotion. *The World Economy*, 30(1): 22–38.
- Saner, R., Yiu, L.* (2003). International Economic Diplomacy: Mutations in Post-modern Times. Discussion Papers in Diplomacy // [clingendael.info](http://clingendael.info).
- State Statistic Service of Ukraine (2014a). Export-import of services with other countries in 2012 // [www.ukrstat.gov.ua](http://www.ukrstat.gov.ua).
- State Statistic Service of Ukraine (2014b). Ukraine's foreign trade in goods // [www.ukrstat.gov.ua](http://www.ukrstat.gov.ua).
- Veenstra, M. van, Yakop, M., Bergeijk, P. van* (2010). Economic Diplomacy, the Level of Development and Trade. Discussion papers in diplomacy // [clingendael.info](http://clingendael.info).
- Ward, J.H.* (1963). Hierarchical groupings to optimize an objective function. *Journal of the American Statistical Association*, 58(301): 236–244.

Стаття надійшла до редакції 5.02.2015.