ECONOMICS & Sociology

Ganna Kharlamova, Olga Vertelieva, The International Competitiveness of Countries: Economic-Mathematical Approach, *Economics & Sociology*, Vol. 6, No 2, 2013, pp. 39-52. **DOI: 10.14254/2071-789X.2013/6-2/4**

THE INTERNATIONAL COMPETITIVENESS OF COUNTRIES: ECONOMIC-MATHEMATICAL APPROACH

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Received: January, 2013
1st Revision: July, 2013
Accepted: October, 2013

DOI: 10.14254/2071-789X.2013/6-2/4

ABSTRACT. This paper pursues three main objectives: (i) to review the existing theoretical approaches towards the phenomenon and definition of "national competitiveness" as an economic category; (ii) to analyze factors affecting the level of national competitiveness, and (iii) to define clusters of countries according to the level of their relative national competitiveness. The main focus is to identify the most appropriate definition of national competitiveness, to use a mathematical approach to test the main hypothesis (H1: there is high correlation between the competitiveness level and the list of factors that can potentially increase/decrease competitive advantages of a state). Data of Ukraine and 29 states that clustered to the same (II) stage of development according the Global Competitiveness Index 2004-2012 are taken for the research. The applied cluster analysis helped to solve the challenge of statistical research of national competitiveness as classifying of countries (data set of 36 states, 2004-2012 years) according to their competitiveness, taking into account national peculiarities. As well cluster analysis lets to test assumptions that there is an existence of some structure in the sample of countries.

JEL Classification: F6, F12, C5, C38

Keywords: competitiveness, globalization, case of Ukraine, competitive index, model.

Introduction

In the past few decades the economic competition between countries has intensified. Most every state aspires to become an influential and important player of international economic relations and take its rightful place at the world economic market to prevent the major risks that globalization entails. Even if there are some doubts that states/nations still compete, it remains the case – as when a market is open it is not only enterprises that compete. As enterprising is only possible under certain state governing environments, thus at the macro level we have the evidence of competition between states – for the resources (like investments, oil), for the environment ("green technologies"), etc. Experience of the world economic crisis has shown that the most vulnerable to external shocks are countries with low levels of national competitiveness. So, the topic of competitiveness (its assessment, enhancing policies) is very relevant and important for the future development of any state.

Nowadays there is no single, uniform approach to the interpretation of national competitiveness as a concept and to the determination of its place in the other basic economic categories. This issue has been the subject of foreign and domestic scholarly studies (Antonjuk, 2004; Lagutin, 2011; Shvidanenko, 2001; Rapkin *et al.*, 1995; Porter *et al.*, 2000; Kulikov, 2000).

The research aim of the paper is to disclose and compare different approaches to the determination of national competitiveness as a complex, contradictory economic category; to apply a mathematical approach (correlation analysis) to measure the impact of trade factors (as main drivers of globalization) on the value of competitiveness index (according to the Global Competitiveness Reports) and to insure the possibility of forecasting this level by means of econometric model; to consider possible division of states by the characteristic of competitiveness with tracking ability to maintain weighted and sound international economic policy.

1. Literature Review

The analysis of current approaches to the interpretation of competitiveness as the concept shows the variation in understanding of this category (*Table 1*).

Table 1. Defining national competitiveness as economic category

Source of the approach	Definition of competitiveness of a state
IMD World Competitiveness Report (http://www.imd.org/news/World-Competitiveness-2013.cfm)	The ability of nations to create and maintain an environment in which enterprises can compete. The ability of an economy to manage the totality of its resources and competencies to increase the prosperity of its population.
Rapkin, David P., Avery, William P. (1995)	A political and economic concept that affect military, political and scientific potential of the country and is an integral factor in the relative position of the country in the international political economy.
Krugman P. (1995)	Equivalent of productivity. But the scientist claims that competitiveness is "wrong and dangerous definition" if to apply for the international level.
Michael E. Porter *et al.* (2000)	Deals with the policy and institutions in the state that promotes long-term growth. "National competitiveness" corresponds to the economic structures and institutions of the state for economic growth within the structure of global economy.
World Economic Forum (WEF) [Global Competitiveness report (GCR)] (2011-2012)	The ability to maintain a steady growth rate of real per capita income, measured by pace of growth in gross domestic product (GDP) per capita at constant prices.
European competitiveness report (2003)	A competitive economy is an economy with a consistently high rate of productivity growth. Competitiveness depends on the performance of the economy's SME-fuelled industry. To be competitive, the EU must outperform its competitors in terms of research and innovation, information and communication technologies, entrepreneurship, competition, education and training.
Kulikov G. (2000)	There are real and nominal competitiveness. Real competitiveness requires openness and fairness of markets, the quality and innovation of products and services in the country of origin and the continued growth of life standard of its citizens. Therefore, the actual degree of competitiveness is a possibility of national industries to have a free and fair market of goods and services that

	meet the requirements of both domestic and foreign markets, and simultaneous growth of real income. Since the nominal competitiveness can be achieved by a particular government policy, creating a macroeconomic environment for domestic producers through direct state subsidies and wage restraint. Thus, the real competitiveness is possible only if national companies are able to effectively design, produce goods and sell them at prices and quality that meets both external and internal customers' requirements – without direct subsidies, control of wages and unemployment.
Ukrainian economic Encyclopedia (Shtaylmann K., Dryahlov M., B. Hartman) (2000)	The ability of one country to compete with the economies of other countries – in terms of efficient use of national resources, increasing productivity of the economy and on that basis to increase standards of living in the state.
Business Dictionary [http://www.businessdictionary.com]	Ability of a firm or a nation to offer products and services that meet the quality standards of the local and world markets at prices that are competitive and provide adequate returns on the resources employed or consumed in their producing.
President's Commission on Industrial Competitiveness (1985)	The degree of capacity of the country for free and fair market produce of goods and services that meet the demands of world markets

The main reason of the multiplicity of definitions of national competitiveness is the complexity of the term; its composite character; moreover, the system concept of the category itself. Competitiveness is a complex multidimensional concept. It reflects the favourable position of the national economy, mainly in the field of international trade and, at the same time, its ability to strengthen this position. On the other hand, the competitiveness of the national economy is a concentrated expression of economic, scientific, technological, organizational, managerial, marketing and other capabilities that are implemented in goods and services, successfully insuring their competing opposite foreign goods and services at the domestic and foreign markets. The national competitiveness is an ability of a state to achieve high rates of economic growth, ensure a steady increase in real wages, promotion of domestic firms on the world market represented by high-performance clusters that improve the quality of products and services that enable the creation of new jobs in the future. This competitive ability to adapt to changes occurring in the global market is based on following economic factors such as investment volume, innovation ability, manufacturing facilities, and others. However, their performance must be combined with political and social factors that also affect the functioning of the national economy in the world market (Antoniuk, 2004).

The analysis of economic development of states over the world through the prism of national competitiveness lets to draw the following models of national competitiveness enhancing (Shevchenko, 2011) (*Fig. 1*):

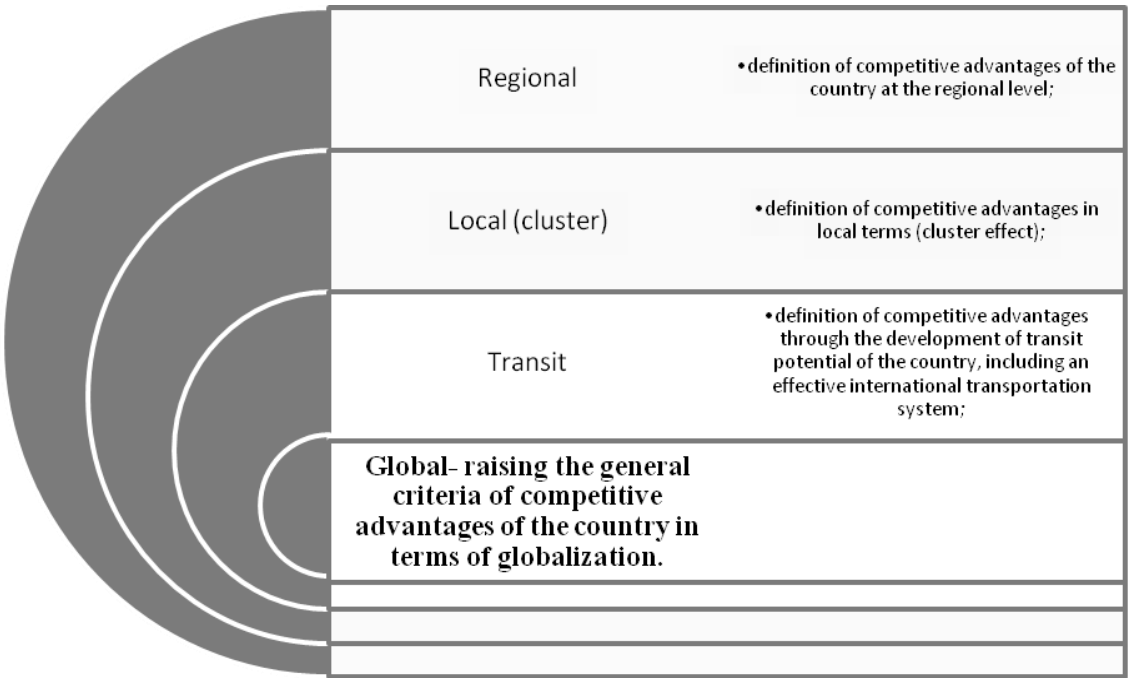

Figure 1. Models of national competitiveness enhancing

So the same stages could be applied for consideration and assessment of any country's national competitiveness: from so called national potential (like investment climate, etc.) till cluster distribution with export-import analysis. And the top, according such logic, is the assessment of national competitiveness as a Rank in Global Competitiveness ratings.

Besides the factors that can affect the level of national competitiveness through the use of appropriate model formulation are (*Fig. 2*):

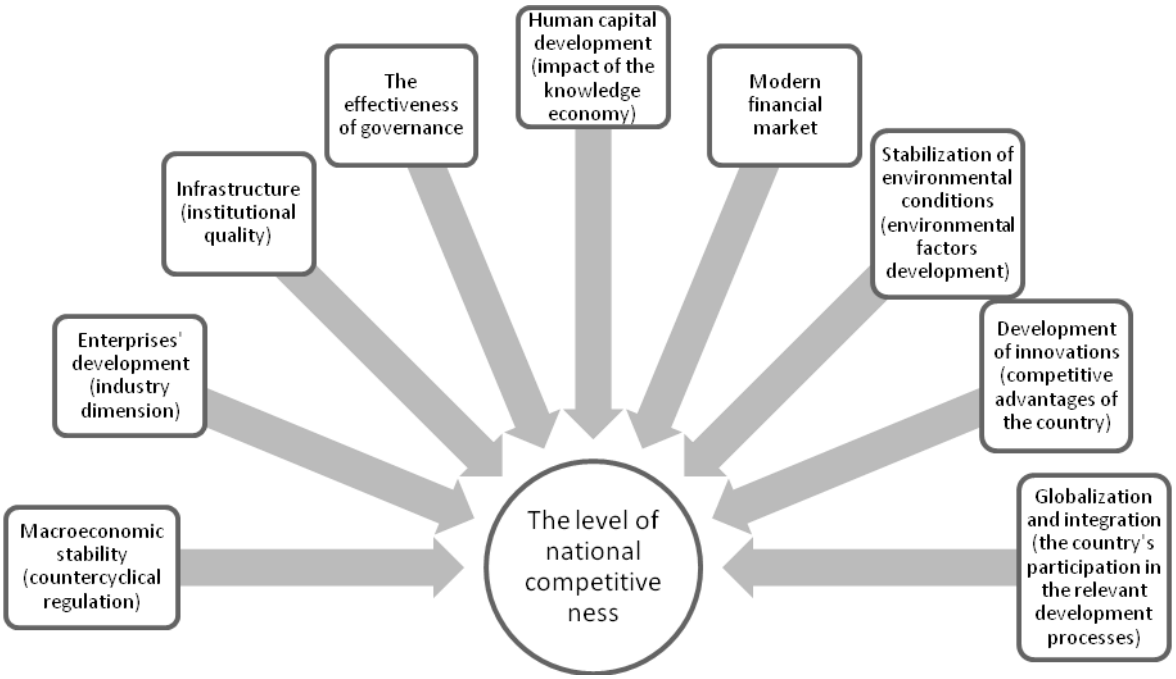

Figure 2. Factors that can support enhancing of national competitiveness

Here we developed the concretization of the Porter's idea (Porter, 1998), that there are three stages of economic development, which are characterized by different criteria in the competition, the level of productivity and income: factor-dependent economy → investment-dependent economy → innovation-dependent economy. Based on M. Porter's ideas World Economic Forum allocated five stages of economic competitiveness (including two transit stages). The annual Global Competitiveness Report distributed countries into five groups according to these stages.

We believe that the quantative part of our paper will light the assessment and the direction for the impact of factors allocated by M. Porter (such as exports and foreign direct investment in the economy) on the national competitiveness of a state.

We highlight the fact that the national competitiveness should be investigated dynamically as it is a function of time in order to team it in mathematical categories. Note also that sectors of the national economy are not always competitive at the same level at the global market. Those firms and industries that are leaders now, in the long run may lose this advantage, giving win to foreign competitors. So the function of competitiveness is a dynamic and multifactorial one.

Considering above-mentioned, we can generalize that the competitiveness of a country is characterized by mechanisms of conditions and resources formation existing in it that contribute to solving problems of national security, economic development and improving of people's life. The state, which has non-economic institutions that are as efficient as economic ones like political and cultural (in the view of its impact at economic processes inside a country), may be regarded as competitive and has huge potential not only for competitive advantage at the global market, but as well has the benefits associated with the distinguishing functioning of the political, cultural and social systems.

2. Globalization and competitiveness: synergetic development

During the recent decades globalization has become the characteristic trend of the global economy; its multi-dimensional performance is in economies of scale and dynamism of the international movement of goods, services and factors of production, information, and technology (Kharlamova, 2013). On the one hand, this process accelerates the convergence of national economies; on the other it leads to increased interstate and interlocked contradictions and increased competition between subjects of international economic relations at regional, sub-regional and global levels.

Globalization is an objective process aimed primarily at implementing the requirements of international competition and making quantitative and qualitative changes in the competitive environment of the countries with both positive and negative effects. First, it reinforces the need for a new economic system based on market economy and thus actualizes the role of competition in general; second, it contributes to the intensification of competition; and third, it dictates a severe competition, and as a result, modifies the competitive relationship.

It is exactly in this feature and appearance of globalization that we see a synergetic effect for every economy and the level of national competitiveness itself. According to Merriam-Webster dictionary, the definition of *SYNERGISM* is: interaction of discrete agencies (as industrial firms), agents, or conditions such that the total effect is greater than the sum of the individual effects. However this synergetic effect is not the same for every country. Thus, the impact of globalization on developing countries is quite ambiguous. On the one hand, it opens up new opportunities for them, and on the other, it can cause significant damage to those countries that have not developed their own existence and strategies in a competitive environment. Some countries can become stronger under globalization and its

competition challenges while others can fail dramatically and overuse their potential. So nowadays the problem of national competitiveness goes beyond mere interest on or the struggle for individual market segments (Lagutin, 2011).

The high level of national competition determines increasing opportunities for the attraction of investment inwards, technology transfer, expanding market presence and signing of new trade contracts for any country. Conversely, low ratings and reviews serve as indicators of underestimation by the governments of certain countries and the need for the prompting of an improved national environment. This can push the companies to struggle for markets.

Every country feels the necessity to compare themselves with other countries for a certain set of criteria that give a sufficiently complete picture of its ability to withstand international competition at their own markets and in the global market.

International competition – a multifaceted economic market category that reflects the struggle of civilizations, regions, countries, global complexes and specialized industries, global and multinational companies, financial institutions and other entities of the global space for competitive advantages. The competition is going on under a high level of monopolization, increasing of the overall impact of previously isolated factors, deepening of the participants' aggressiveness. All mentioned facts increased complexity of paradigm shift in states' development (Shvidanenko, 2007)

So the economy of any country cannot develop and gain great competitive status if it is limited only by its own logical and scientific basis, operating in closed loop. World development, guided by the requirements of globalization for the free movement of factors of production and labour involves the openness of national borders. The distinguish features of economic globalization is unification and integration of the world economy and its unique synergistic effect. So, the globalization creates for every economy (state) the following range of internal and external competitive advantages (factors) (*Fig. 3*):

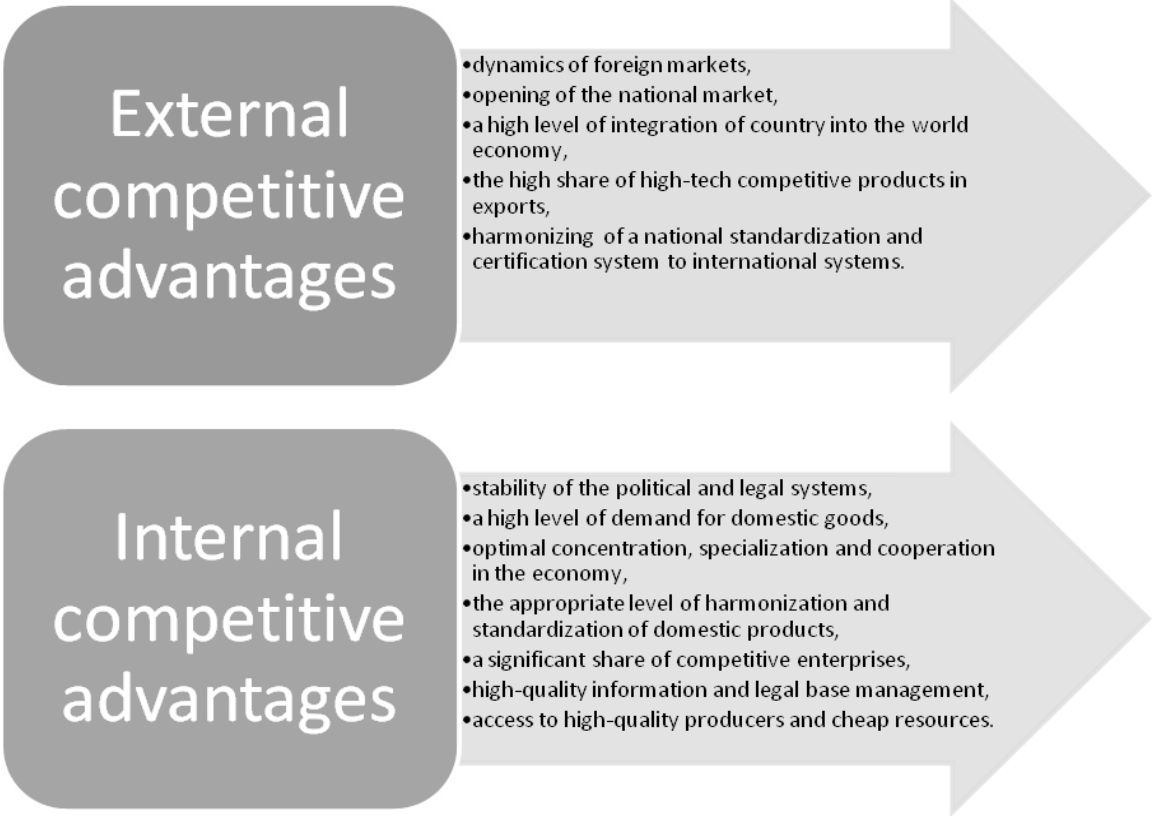

Figure 3. Internal and external competitive advantages of a state

So the current level of global competition has led to the formation of a competitive advantage paradigm (*Fig. 3*) which is mainly characterized by:

- continuous necessity of innovations;
- formation of such competitive advantages that cannot be easily replicated by competitors;
- high necessity to overcome the low level of technological, social, spiritual culture and management culture in order to become a member of international society.

Investment climate and business environment, economic freedom and human rights, quality of governance – are the factors that mostly determine the country's capacity to ensure the performance of the economy, to create conditions for improving the competitiveness of its businesses and, as a result, improve living standards under globalization (Kharlamova, 2011).

Thus, analyses of the theoretical component of current national competitiveness models (*Fig. 1*) and approaches to its definition (*Table 1*), lets us to believe that the core of the modern national model of competitiveness is the usage of national (internal) competitive advantages based on innovations. At the same time globalization as free-open trade concept can highly affect the models of national competitiveness.

3. Competitiveness level: research methodology, assessment and forecast

The logic of this research is to test by means of mathematical methods (correlation/regression analysis) the theoretical hypothesis *H1: There is high correlation between competitiveness level and the list of factors that can potentially increase/decrease competitive advantages of a state under globalization.*

So we come to the investigation of the most influential factors on the national competitiveness by means of econometric models and forecasting technique. Data set: data of Ukraine from the Official statistics (www.ukrstat.gov.ua) of 2004-2012 (2004 was the first year when World Competitiveness Index was calculated for Ukraine).

Analysis of studies of foreign and domestic scholars, international rating agencies, conducted in the previous section pushed to the idea that the factors that mostly determine the competitiveness of any country under globalization could be following (in the simplest extent): GDP, FDI inflows, foreign trade balance, export. Using the regression analysis we check which of the factors have the greatest impact on the national competitiveness of a state (ex., Ukraine) in the considering time period. Descriptive statistics of data set (*Table 2*) shows that we can forward in application of correlation analysis.

Table 2. Descriptive statistics of variables and results of correlation analysis

Part-A descriptive statistics			Part-B correlation analysis*				
Variables	Mean	SD	CI	ΔFDI	Export	GDP	Saldo
CI	3,79	0,15	1,00				
ΔFDI	3,64	0,08	0,84	1,00			
Export	5,57	0,08	0,93	0,65	1,00		
GDP	5,89	0,07	0,82	0,99	0,62	1,00	
Saldo	-7,75	0,19	-0,85	-0,83	-0,75	-0,81	1,00

* Correlation is significant at 0.05 level (2-tailed), where:
CI – Ccompetitiveness index (score value; not ordered value, but ranging in diapason from 1 till 7);
ΔFDI – foreign direct investments (FDI) increase, billion USD;
Export – export volume, billion USD;
GDP – GDP volume, billion USD;
Saldo – foreign trade balance, billion USD.

Correlation analysis shows:

- there is high significant correlation between CI and factors (H1+);
- there is opposite dependence between foreign trade balance and competitiveness;
- there is high multicollinearity between factors. So, for application of regression analysis we cannot take factors altogether during application of Least Squares method of regression (*Table 2*).

Taking in account the small ratio of data available (variables amount / observation amount = 4/9 (for the case of Ukraine)) we decided to consider a range of approximately possible variants of short time series (9 observations) modelling, like:

1) taking in account all factors in one stepwise regression (for minimizing the multicollinearity);
2) one factor LS-regressions for every combination of independent factor and CI as a dependent variable (4 separate regressions);
3) modeling trend for CI (time series analysis);
4) multinomial logistic regression if to consider CI as a score from 1 to 7. The theory background (Green, 1993) says: the idea is to construct a linear predictor function that constructs a score from a set of weights that are linearly combined with the explanatory variables (features) of a given observation using a dot product: $score(X_i,k)=\beta_k \cdot X_i$, where $\mathbf{X}_i$ is the vector of explanatory variables describing observation i, $\boldsymbol{\beta}_k$ is a vector of weights (or regression coefficients) corresponding to outcome k, and $score(\mathbf{X}_i, k)$ is the score associated with assigning observation i to category k. The predicted outcome is the one with the highest score. However the main inappropriate in such type model application to our research is that CI is not discrete-ordered variable (Green, 1993).

We sum up received regression model results in following *Table 3*.

Table 3. Regression models for CI as a dependent variable (case of Ukraine)

Type of regression	Adj.R^2	Prob.(F)	Significant variables/Total independent variables considered (p-value=0,1)	DW	Akaike info criterion
Step-wise regression	0.93	0.003	1/4	3.00	-1.28
CI-GDP	0.67	0.004	1/1	0.82	0.26
CI-ΔFDI	0.85	0.0002	1/1	1.85	-0.53
CI-EXPORT	0.62	0.007	1/1	0.83	0.38
CI-Saldo	0.68	0.004	1/1	1.98	0.21
CI-logarithmic trend	0.79	0.0008	1/1	0.82	-0.2
Multinomial logistic regression	Not enough observations				

The results accumulated in *Table 3* forward us to the conclusion that the most appropriate from the range of estimated models is CI-Saldo LS one-factor model:

CI = -0.057*SALDO + 3.35,
(0.003) (0.000)

All variables are significant at 95% level of reliability, no autocorrelation or heteroscedasticity is detected for the model. So, we can assume that 68% of CI variance is determined by foreign trade balance variance in the average under saving of same trend for the case of Ukraine.

If we use the estimated model for modeling and forecasting of the national competitiveness level, we receive *Figure 4*, which shows rather good simulation ability of the model for the dynamics of the Ukrainian Competitiveness Index (2004-2012 years).

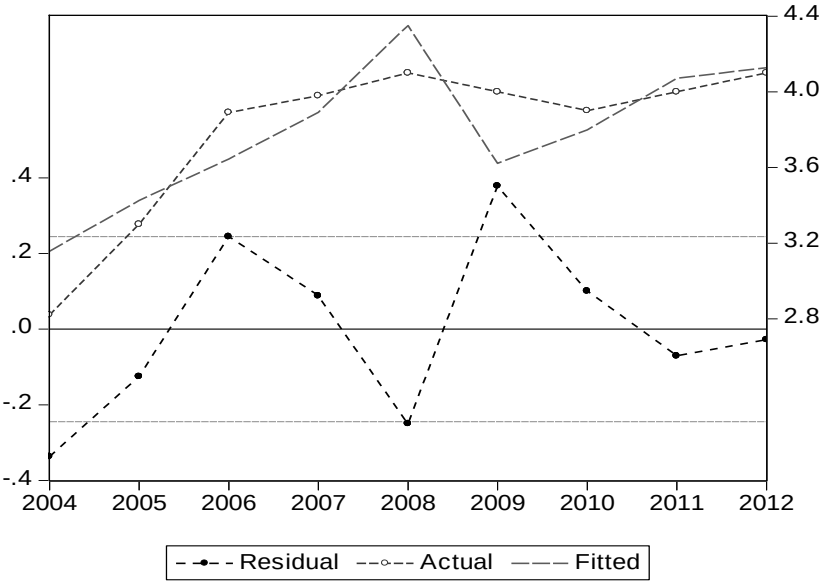

Figure 4. Comparison of the Global Competitiveness Index (red –o- line) and the data obtained from the model (green --- line) (case of Ukraine), points
Source: based on authors estimations.

At the next step of the investigation we constructed a forecast of competitiveness levels of Ukraine in 2013-2015 years (*Fig. 5*).

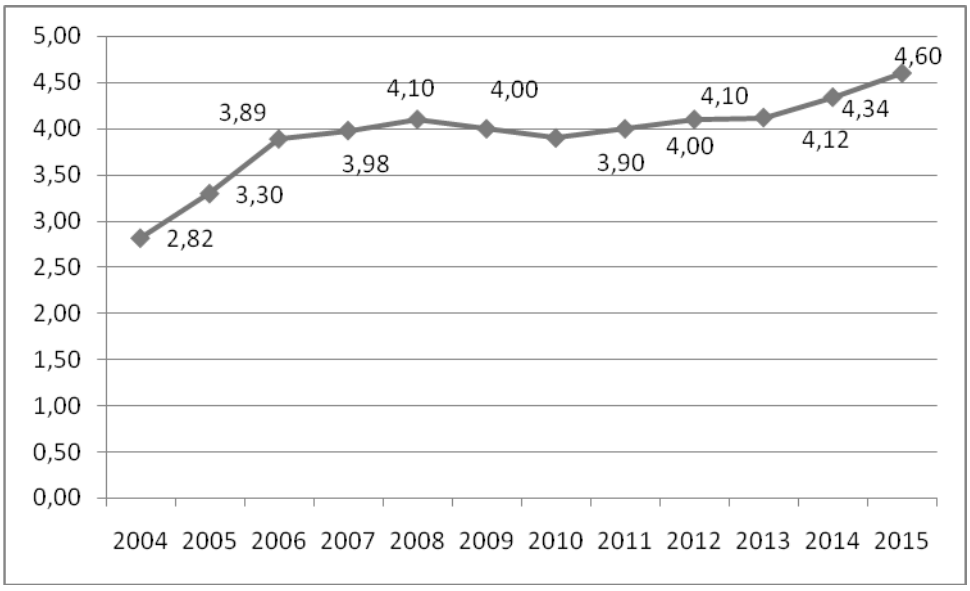

Figure 5. Competitiveness Index 2004-2012 for Ukraine and forecasted data for 2013-2015, points
Source: based on authors estimations.

The most remarkable outcome is that we can forecast for this model case the possibility of sure increasing tendency for the CI of Ukraine (*Fig. 5*).

However, there could be a discussion arguing that the results are not so convincing because of a shortage of observations. Certainly, the future periods in history of Ukraine will add representativeness for the model. But for the current moment of research it seems valuable to broad application analysis in consideration of pool data analysis that substantially increase the number of observation (from 9 up to 9 x amount of states) and the analysis will yield real evidence about the relationships between independent and dependent variables. As well, for such kind of macro studies we propose to use Granger causality test to the hypothesis H2: *There is causality between competitiveness level and the list of factors that can potentially to increase/decrease competitive advantages of a state under globalization: factor's level is cause for CI level.*

We pushed off the following theory that correlation does not necessarily imply causation in any meaningful sense of that word. The econometric graveyard is full of magnificent correlations, which are simply spurious or meaningless. The Granger (1969) approach to the question of whether x (independent variable) causes y (depended variable) is to see how much of the current y can be explained by past values of y and then to see whether adding lagged values of x can improve the explanation (Green, 1993).

Data set: 29 states that clustered to the same (II) stage of development according the Global Competitiveness Index 2004-2012: Albania, Armenia, Bosnia and Herzegovina, Bulgaria, China, Colombia, Costa Rica, Dominican Republic, Ecuador, Georgia, Guatemala, Indonesia, Jamaica, Jordan, Macedonia, Mauretania, Montenegro, Morocco, Namibia, Panama, Paraguay, Peru, Romania, Serbia, South Africa, Suriname, Swaziland, Thailand, Ukraine.

Application of Causality Granger test in EViews for the accepting or rejecting of the latter hypothesis H2 gave the following results.

Table 4. Granger causality test results for 29 states that clustered to the same (II) stage of development according the Global Competitiveness Index 2004-2012

Null Hypothesis:	F-Statistic	Prob.
EXPORT does not Granger Cause CI	0.65916	0.6027
CI does not Granger Cause EXPORT	0.38109	0.7241
FDI does not Granger Cause CI	12.3693	0.0148
CI does not Granger Cause FDI	0.59208	0.6281
GDP does not Granger Cause CI	1.49774	0.4004
CI does not Granger Cause GDP	0.04829	0.9539
SALDO does not Granger Cause CI	1.25668	0.4431
CI does not Granger Cause SALDO	1.67622	0.3737
FDI does not Granger Cause EXPORT	1.03924	0.4904
EXPORT does not Granger Cause FDI	2.55664	0.2812
GDP does not Granger Cause EXPORT	0.01105	0.9891
EXPORT does not Granger Cause GDP	0.25369	0.7976
SALDO does not Granger Cause EXPORT	0.30566	0.7659
EXPORT does not Granger Cause SALDO	0.41278	0.7078
GDP does not Granger Cause FDI	3.04816	0.2470
FDI does not Granger Cause GDP	0.30316	0.7674
SALDO does not Granger Cause FDI	0.54276	0.6482
FDI does not Granger Cause SALDO	2.15972	0.3165
SALDO does not Granger Cause GDP	1.33372	0.4285
GDP does not Granger Cause SALDO	2.56259	0.2807

There is mutual co-causality between CI and all considered factors but the one-way direction between CI and FDI (*Table 4*). We cannot reject the hypothesis that CI does not Granger Cause FDI but we do reject the hypothesis that FDI does not Granger Cause CI. Therefore it appears that Granger causality runs one-way from FDI to CI and not the other way.

We attempted to calculate ordered multinomial logistic (mlogit) regression model using the panel (longitudinal) data what appeared to be the most exciting for the objectives of the research but we came to the conclusion that such a regression analysis is NOT possible with SPSS, EViews and STATA (only reoprob can run this type of regression but not using panel data). Moreover, mlogit only handles binary variables. Thus, for the idea of gross data regression model the most significant and free from autocorrelation and heteroscedasticity the multinomial logistic regression that considered for the data of the states (not as a panel but as variants of combinations) appeared to be.

Table 5. The multinomial logistic regression result

Method: ML - Ordered Logit (Quadratic hill climbing)				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
GDP	0.009542	0.004485	-2.127379	0.0334
FDI	8.58E-05	3.04E-05	-2.819706	0.0048
Export	0.010412	0.024460	-0.425662	0.6704
Saldo	-0.007353	0.021710	-0.338703	0.7348

McFadden R-squared = 0.67, that is appropriate result. However the interpretation of the coefficient values is complicated by the fact that estimated coefficients from an Ordered Logit model cannot be interpreted as the marginal effect on the dependent variable. The most valuable result of the estimated model is the fact that for considered group of states (II stage according Global Competitiveness Index) factors “Export” and “Saldo” are insignificant for CI forecasting.

4. Clustering of states according to their competitiveness level

The next step of our research methodology is to consider states in their similarity/difference according to the level of competitiveness. We use cluster analysis for typology of countries in terms of international competitiveness.

The task of cluster analysis is to split the set of G objects on m (m – integer) clusters (sub-sets) Q1, Q2 … Qm, basing on data of X set, so that every Gi object belongs only the one cluster and that objects in the cluster are to be the most similar to each other, at the same time, objects in different clusters have to differ maximum from each other (Hastie *et. al.*, 2009). The purpose of clustering in the analysis of the national competitiveness is the formation of groups of similar to each other countries in terms of competitiveness and its dynamics in order to identify patterns that are characteristic for a particular group of countries. In order to decide which clusters should be combined (for agglomerative), or where a cluster should be split (for divisive), a measure of dissimilarity between sets of observations is required. In most methods of hierarchical clustering, this is achieved by use of an appropriate metric (a measure of distance between pairs of observations), and a linkage criterion which specifies the dissimilarity of sets as a function of the pair-wise distances of observations in the sets (Hastie *et. al.*, 2009).

The Global Competitiveness Index 2004-2012 is used as the assessment of the competitiveness level, calculated by the World Economic Forum. To construct a multi-

dimensional grouping of countries according to their level of competitiveness we form relevant sample, which got 36 from 144 countries for which the index is calculated. The necessity of such sample is determined by ensuring the visibility of resulting cluster groups. The sample was made using of 25% mechanical selections.

At the next step, we applied hierarchical clustering (Hastie *et. al.*, 2009) – there are clearly segregated five large clusters at the result dendrogram (*Fig. 6*).

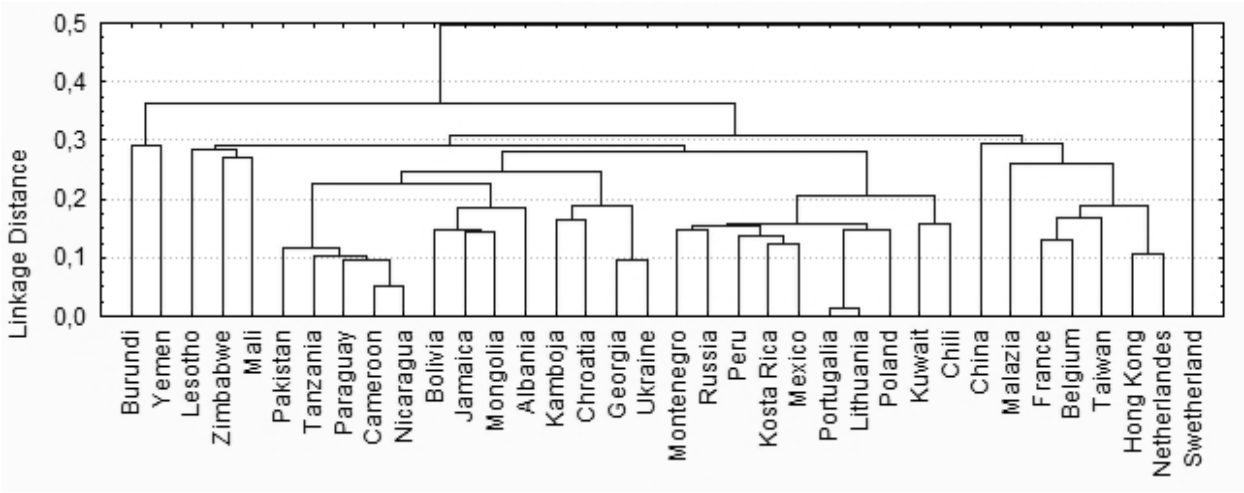

Figure 6. Dendrogram of clusters of countries at period of 2004 - 2012 years
Source: based on authors estimations.

Consequently, for the estimation the average level of these indicators, which is characteristic for these groups of countries with a certain level of competitiveness, we apply iterative method of k-means clustering based on such factors as: the volume of export in 2011, mln. USD; the volume of GDP in 2011, mln.USD; foreign direct investment inwards in 2011, mln. USD; Global competitiveness Index, points, 2011 – 2012 – these factors we considered as highly positively correlated with CI at the previous stage of the research.

Having information about the most appropriate amount of clusters for considered states we apply k-means cluster technique: *k*-means clustering aims to partition *n* observations into *k* clusters in which each observation belongs to the cluster with the nearest mean, serving as a prototype of the cluster. Given a set of observations (x_1, x_2, …, x_n), where each observation is a *d*-dimensional real vector, *k*-means clustering aims to partition the *n* observations into *k* sets ($k \leq n$) S = {S_1, S_2, …, S_k} so as to minimize the within-cluster sum of squares (WCSS):

$$\underset{s}{\operatorname{argmin}} \sum_{i=1}^{k} \sum_{x_j \in S_i} \left\| x_j - \mu_i \right\|^2$$

where μ_i is the mean of points in S_i (Hartigan, 1975).

The implementation of such k-means clustering method makes it possible to divide the countries into 5 clusters according their level of competitiveness and similar factors impact on this characteristic (*Table 6*): 1 – countries with very low level of competitiveness, 2 – countries with low level of competitiveness, 3 – countries with an average level of competitiveness, 4 – countries with a high level of competitiveness, 5 – very competitive countries.

Table 6. Clusters of countries according to their level of competitiveness received by k-means cluster analysis

Cluster	Amount of states	List of countries
1	6	Pakistan, Mali, Zimbabwe, Lesotho, Yemen, Burundi
2	10	Montenegro, Cambodia, Albania, Mongolia, Jamaica, Bolivia, Nicaragua, Cameroon, Paraguay, Pakistan
3	12	Chile, Kuwait, Poland, Lithuania, Peru, Portugal, Mexico, Costa Rica, Russia, Ukraine, Croatia, Georgia
4	4	Taiwan, Belgium, France, Malaysia
5	4	Switzerland, the Netherlands, China, Hong Kong

Source: based on authors estimations

According to our results the most competitive are Switzerland, the Netherlands, Hong Kong and China. These states are characterized by significantly higher volumes of export and FDI inwards. China managed to get in the cluster of very competitive states due to high volume of export of goods and services. The largest number of countries is included in the cluster of middle-competitiveness – 12. Ukraine also came to this cluster of countries. The least competitive countries are Pakistan, Mali, Zimbabwe, Lesotho, Yemen, and Burundi.

Thus, the method of cluster analysis helped to solve such problems of statistical research of national competitiveness:

- classification of countries according to their competitiveness, taking into account national peculiarities: this task solving will deepen the knowledge of the formation of the competitiveness index for a particular group of countries;
- testing of assumptions about the existence of some structure in the studied sample of countries, thus finding such structure;
- construction of new classifications in order to establish connections within a sample, as well as its structure.

Conclusions

The main reason for the multiplicity of definitions of competitiveness is its complexity, composite character, and the systematic concept of itself as a category. We tried to consider national competitiveness from the position of its synergetic effect with globalization and concluded that it mostly appeared under the globalization of trade and investing. The more countries are open to international trade, the more important and sound for them is the competitive level and its indexes.

We applied the mathematical method to test our hypothesis, and validated our original assumptions. The model's assessment showed that the greatest way to affect the national competitiveness level is to change the country's volume of foreign trade balance.

We used the cluster analysis technique to consider the agglomerations of states according to their level of competitiveness. The results of cluster analysis of 36 countries sample allocated five main homogeneous clusters of countries.

By having this information while conducting similar analysis every year each country can easily develop its own national strategy, see its partners and contradictors in the same cluster and in neighbouring clusters, and maintain a proper "strong-weak" points policy to reach the high level of economic development and sustainability. And the pushing of national "buttons" – like foreign trade balance volume determination – is able to "turn on" international state forces – like competitiveness level increase. Finally, there is strong

evidence that the higher the level of national competitiveness a state has, the more sustainable the level of the economy and the higher the living standard that occurs in it.

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