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Modeling the Multi-Dimensional Indicators of Regional Integration Processes

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Abstract—**The approaches of modeling multi-dimensional indicators of regional integration processes and assessment of impact of deepening of integration cooperation are determined in the article.**

The authors propose scientific and methodological approach to the assessment of the potential of the development of regional integration processes based on the use of the integral index of the potential of integration processes development, which takes into account the intensity of the influence of internal and external factors of the development of integration interaction. The approaches of the integrated assessment of the development of regional integration processes are identified based on various aspects (trade integration, industrial integration, market integration), which provides a comparative analysis of the global regions development or individual integration associations according to the development level of integration processes.

Keywords—regional integration, multi-dimensional evaluation, integral index

I. INTRODUCTION

Integration processes that determine the key trends in the development of the modern world economy at the regional and global levels are the subject of constant scientific research. According to the World Trade Organization, at the beginning of 2019, 467 regional integration agreements were notified, 291 of them are active. These facts indicate further development and expansion of regional integration processes in the world. Determination of various aspects of the impact of intensification or weakness of the integration interaction on the nature and patterns of economic development specifies the relevance of the study.

Special studies on regional economic integration are carried out by various institutions: the World Bank, the World Trade Organization, the UN, and others (see statistics database UN COMTRADE, which includes world integration associations: http://www.unstats.un.org). Special researches of the regional integration are also implemented in the framework of the UN University Programme on Comparative Regional Integration Studies (see Regional Integration Knowledge System): www.cris.unu.edu/riks).

II. RELATED WORK

Different aspects of the assessment of regional integration processes are presented in scientific studies of P. Lombaerde, G. Pietrangeli, C. Weeratunge [1] which measure the level of integration development at the level of regional groups. Continuing research done by P. Lombaerde, I. Iapadre, A. McCranie, L. Tajoli focus on a network analysis of the study of globalization and regionalization as a complex and multi-dimensional phenomenon, laying emphasis on trade, investment, migration and political components [2]. L. Guiso, H. Herrera, M.Morelli [3] conducted research on cultural component influence in integration processes development, wherein the desirability of institutional integration with the existing cultural diversity is elaborated. C.-Y. Park, R. Claveria proposed to take into account assessing the integration processes such components as trade, monetary and finance integration, infrastructure and connectivity, regional value chain, migration and social integration [4]. A.Akbari, L.K. Ng, B.Solnik [5] suggest assessment of market integration, taking into account economic integration (by defining the overall dynamics of cash flows) and financial integration (through the definition of overall pricing and risks dynamics).

R. McDougall [6], S. Schill, G. Vidigal [7], in their work, define the mechanism for settlement of dispute and regional trade agreements. Br. Russett, H.Starr, D. Kin-Sella [8] investigate the economic interrelationship that manifests itself in intra-regional trade as one of the criteria for regional integration. Scientific works of R. Baldwin, L.-G. Javier [9] are connected to the researches on the processes of industrial integration and international production networks. In their research V. Aggarwal, S. Evenett [10] emphasize the definition of changes in the main economic and political parameters that influence the development of regional integration processes in modern conditions.

Based on the study of the processes of European integration J. König [11] proposes a system of complex indicators (acquis communautaire (measured by "EU Compliance"), Single Market integration ("EU Openness and EU Importance"), Economic and Monetary Union

("EU Symmetry"), and economic convergence ("EU Homogeneity")), enabling to assess the stage of involvement of heterogeneous European countries to integration processes using elements of cluster analysis. S.Becker, P.Egger, M.Von. Ehrlich [12] studied integration processes and proposed a mechanism for measuring and assessing the impact of the EU's regional policy effects.

In the presented studies, the research of certain aspects of regional integration depends on the specifics, defining features and peculiarities of their development, which, in turn, requires sound analysis methods that can provide the most objective, reliable and integrated assessment of the studied aspects. Therefore, the actual task is still the development and synthesis of possible methods of quantitative and qualitative analysis of the development of integration processes, assessment of economic impacts and the effectiveness of the integration cooperation strengthening between countries and regions.

From the point of view of the evaluation tools, the integration process is multi-dimensional, complex both in terms of components, elements, manifestations, levels, etc. This is conditioned by the fact that the approach to study the development of integration processes used in the scientific literature that manifests itself in the functioning of regional integration associations, only on the basis of

tools of content (qualitative) analysis with the additional application of some individual quantitative indicators, reflecting various aspects of the manifestation of integration processes, doesn't allow to obtain a systematic or complex view of their development patterns, in particular in the aspect of obtaining generalized assessments of positive and negative integration impacts, the definition of objective quantitative criteria (indicators) of assigning various integration associations to effectively functioning and not functioning entities, the determination of the general impacts of the effectiveness of the countries participation in such associations, etc.

Therefore, the most successful analytical tool is the multi-dimensional statistical analysis method [13,14], multi-dimensional scaling, which allows to make construction of integrated indicators or integral estimates, which in most cases are multi-dimensional averages according to their form.

III. PROPOSED APPROACH

On the basis of the conducted researches [15] several variants of formation of the integral index of the development of integration processes are proposed, the structure (combination of single parameters) of which is presented in the Table 1.

TABLE I.   APPROACHES TO FORMATION OF MULTI-DIMENSIONAL (INTEGRAL) INDEXES OF THE DEVELOPMENT OF INTEGRATION PROCESSES

first approach		second approach		
Integral index of integration development potential (IPD$_i$) $$IPD_i = \sqrt{Iint_i * Iext_i}$$		Aggregated integration index (AII) $$AII = \sqrt[3]{TII * PII * MII}$$		
Intraregional factors I_{int_i}	External factors I_{est_i}	Trade integration index(TII)	Production integration index(PII)	Market integration index (MII)
Intraregional trade per capita (millions of USD, X_{Intra})	Share of the integration association's regional trade in the world trade (%, $X_{Intra}S$)	The volume of intraregional trade (turnover) per capita, (USD, $ITpc_j$)	Investment volumes per capita (USD, $FDIpc_j$)	The GDP of integration association per capita (USD,$GDPpc_j$)
Share of intraregional trade in the total foreign trade, % *(%, ITS)*	Share of the integration association's investment in the world investment (%, $FDIS$)	Share of intraregional trade (%, d_{ITj})	Share of integration association in the world investment volume (%, d_{FDIj})	Share of integration association in the world GDP (%, d_{GDPj})
ICT share of intraregional export *(%, $X_{Intra\,ICT}$)*	Share of the integration association's GDP in the world GDP, (%, $GDPS$)	Share of integration association in the world trade (%, d_{Xj})	Financial openness index (IFI_j)	The share of the population of the integration association in the population of the world (%, d_{Nj})
Investment rate per capita, (USD, FDI)	Share of the integration association's population in the world population (%, $PopS$)	Intraregional trade intensity index ($ITIIj$)	Share of ICT intraregional export (%, d_{XICTj})	Concentration index(CI)
GDP per capita of the integration association (USD, GDP)	Share of the integration association's ICT export in the world ICT export (%, $X_{ICT}S$)	Intraregional and extraregional trade index ($MTIIj$)		Diversification index(DI)
				Complementarity index (TCI)
$$I_{int_i} = \sqrt[5]{P_{X\,intra_i} \cdot P_{ITS_i} \cdot P_{X\,intraICT_i} \cdot P_{FDI_i} \cdot P_{GDP_i}}$$ $$I_{ext_i} = \sqrt[5]{P_{X\,intraS_i} \cdot P_{PopS_i} \cdot P_{X\,ICT\,S_i} \cdot P_{FDIS_i} \cdot P_{GDPS_i}}$$		$$TII = \sqrt[5]{IT_{PCj} * d_{ITj} * d_{Xj} * ITII_j * MTII_j}$$ $$PII = \sqrt[4]{FDI_{PCj} * d_{FDIj} * IFI_j * d_{X\,ICT\,j}}$$ $$MII = \sqrt[4]{GDP_{PCj} * d_{GDPj} * d_{N\,j} * CI * DI * TCI}$$		

Within the first approach, the multi-dimensional assessment of the integral processes development is presented in terms of factors that determine the nature of the participants` integrative interaction; within the second one- in terms of functional aspects of integrative ties manifested. The peculiarity of the assessment under the second approach, unlike the first one, is that the indices (parameter units) are represented only by relative values (those of intensity, structure and indices), which makes it possible to during the assessment to take into account the volume (size) and socio-economic development potential of the objects, which are subject to comparative multi-dimensional assessment (global regions, integration unions, etc.). Within the scope of this method, in addition to systematization and classification issues of parameter units, the presentation of the integral assessment form and its components is considered a chief methodological aspect of the analysis. This form can be expressed through arithmetic, geometric, quadratic indices. On the basis of the research conducted the use of average geometric indicators was proved to be the most accurate aggregation form.

Conclusions on the appropriateness of using this form of an integral index are based on the axiomatic approach of I. Fisher [16], which, contrary to other methods, in our opinion, is characterized by rigid and high level of mathematical validity. Provided that if the integral index in the form of a function F satisfies four axioms

(monotony, positive linear homogeneity, identity, multiplicity), then it can only be a geometric average.

Another issue of a methodological nature arises when applying the multi-dimensional assessment method which is the choice of standardization or rationing methods of parameter units, which allows, prior to aggregating them in the corresponding indices, to bring them into a comparable form. The most common standardization methods are the selection of the minimum and maximum, average, normative or reference values as the basis of comparison.

The above-described methodological tool for modeling multi-dimensional indicators of integration processes development allows:

– to develop the ratings of integration associations or global regions according to the corresponding integral indicators both within one period of time and over time;

– using the comparative analysis within specific time periods to determine the level and nature of integrative cooperation within integration groups or global regions;

– using statistical dynamic analysis tools of integral indicators to determine formation patterns and development trends within integration cooperation;

– to conduct factor analysis of the integration processes development, in particular, to establish which indicators or groups of indicators and to what extent determine the overall level of integration processes development by region or separate integration associations.

Regarding quantitative evaluation criteria, the most simple, but informative ones, depending on the nature of the analyzed data sample, can be considered correlation and elasticity coefficients.

The correlation coefficient (linear) is a quantitative correlation ratio meter, and according to the generally accepted scale, R. Chaddock scale [17] it makes it possible to differentiate between the weak, moderate, noticeable, close and very tight levels of communication.

The elasticity coefficient can be applied to estimate the relative change in the integral index of the integration processes development due to the dynamics of its subindices, using the formula:

$$Ex,y = \frac{K_y}{K_x} = \frac{y_i - y_0}{y_0} \div \frac{x_i - x_0}{x_0} \qquad (1)$$

wherein y is the integral integration processes development index,

x – subindices, which serve as components of the integral index,

K – indicators growth rates.

The calculated elasticity coefficients characterize the relative change (in percentages) of the integral index by changing the corresponding subindices by 1%.

Another methodological analysis aspect the may be the possibility of using the calculated integral indexes as explaining variables (factor characteristics) when constructing economic and mathematical models, with the help of which it is possible to describe the changes taking place in the global economic environment under the influence of the integration processes reinforcement.

A special place in the integration processes development analysis is taken by the tools of economic and mathematical modeling, which are mainly used by many researchers to assess the influence the signed regional trade agreements might have on both countries acting as Parties to the agreement and on the rest of the world prior to (ex-ante) and after (ex-post) adherence to the relevant agreement; in terms of assessment of the impact integration has on trade flows and economic growth, on the availability of convergence of economic indicators between member states, on determination of the most desirable partner and the most efficient and superlative form of agreements mentioned.

Amidst the econometric methods for assessing the effects of existing free trade agreements and the effects of agreements to be concluded, gravity models are popular, among which the most widely used model is that of J. Tinbergen [18], which is based on the assumption that the bilateral interaction of national economies is a value proportional to the product of the indicators of the significance of the objects (the value of the gross domestic product) and inversely proportional to the distance between them. Consequently, the intensity (volume) of trade between countries is directly proportional to the size of the economies and is inversely proportional to the costs of transporting goods modeled by the distance between countries.

Since integration processes are characterized by a constant deepening of interaction forms and the emergence

of new cooperation tools, there is an objective need to improve and develop tools for their evaluation in the aspect of applying methods of economic and mathematical modeling. Thus, a third approach to the modeling of regional integration processes is proposed, depending on the assessment of the effects of deepening the integration cooperation of countries, associations of countries or regions [19]. The developed approach is based on the following assumptions:

Firstly, the nature, scale and intensity of integration cooperation to a large extent determine the overall level of socio-economic development of countries and regions, assessment indicator of which is the gross domestic product per capita index. At the same time, foreign economic relations between countries and regions, the development level of industrial-cooperative, integration, trade, scientific and technical ties affects the formation of a certain socio-economic development level.

Secondly, in the context of deepening the integration of countries and regions, a combination of their joint efforts takes place, including various types of resources, which in its turn creates the preconditions for achieving a greater effect from international economic activity, which subsequently affects the growth of their joint welfare level.

Thirdly, international trade relations, international investment ties, and international migration processes are among the main traditional forms of development of international economic relations that are characterized by substantial development and determine the nature of economic dynamics and the rates of economic growth of countries and regions. As quantitative indicators of their assessment in statistical practice, the volumes of trade in goods, volumes of trade in services, volumes of direct foreign investments, volumes of money receipts to the country from international migrants are used.

Taking into account the assumptions above, the assessment of the integration cooperation impact of countries on the level of their socio-economic development can be carried out with the help of an algorithm consisting of several interrelated stages and is based on the construction of a system of economical and mathematical models that will eventually determine the effect of the interaction of integration cooperation participants, and define whether it is expedient to deepen the integration links between them.

Consequently, the implementation of the specified stages involves the following:

1. Building up an economic models system that will mathematically describe the impact on the level of social and economic development of the country (region) of various forms of international economic activity. Each of these models will be a regressive dependence of GDP per capita on the trade volumes of goods and services, FDI and migrant revenues (simpler as a lineal multifactor regression). Though, this dependence must be built up in three ways, such as: for the country (region or association) i (2), for the country (region or association) j (3), for the foreseeable unification of the countries (regions) i and j (if they implement their joint economic activity as a result of

deepening of the integration interaction) (4).

$$GDPpc_i = f(MT_i; TS_i; FDI_i; MR_i) \qquad (2)$$
$$GDPpc_j = f(MT_j; TS_j; FDI_j; MR_j) \qquad (3)$$
$$GDPpc_{i+j} = f(MT_{i+j}; TS_{i+j}; FDI_{i+j}; MR_{i+j}) \qquad (4)$$

The development of the economic and mathematical models system (2) – (4) should be accompanied by an appropriate statistical analysis and an assessment of the significance, adequacy and accuracy of the reflection of relationships based on the criteria of Student, Fisher, error of approximation and determination coefficient. For the further application of models in the context of evaluating the effects of the integration interaction, they should be evaluated as adequate, statistically accurate, model parameters should be statistically significant.

2. An assessment of the amount of economic effect from the integration of the countries (regions) i and j based on (5):

$$\Delta GDP = GDPpc_{i+j} - (GDPpc_i + GDPpc_j) \qquad (5)$$

As a result, two alternatives are possible. Firstly, if $\Delta GDP > 0$ we conclude that the cooperation of the members of the association is an effective one, the cooperation between them is mutually beneficial. Secondly, if $\Delta GDP < 0$, cooperation is ineffective, cooperation is not advisable to be developed and deepened.

An approbation of the proposed modeling approaches for multi-dimensional indicators of the regional integration processes development from the point of view of the factors, which determine the nature of the integration interaction of the participants revealed that the EU has the largest potential in terms of subindices that characterize the influence of the intraregional component on the overall integral indicator of the development of integration processes.

TABLE II. DYNAMICS OF INDICATORS OF THE INTRAREGIONAL COMPONENT OF THE INTERGRATION PROCESSES POTENTIAL

Integration association indicator		2000	2005	2010	2015	2016
Xintra	APTA	14,9	47,7	98,7	121,5	113,1
	ASEAN	187,1	294,7	441,1	444,9	429,8
	EU	3322,9	5522,4	6625,6	6594,5	6663,2
	NAFTA	1628,8	1874,9	2062,1	2378,5	2271,7
ITS	APTA	7,9	11,0	12,1	11,5	11,6
	ASEAN	23,0	25,2	25,0	24,3	24,2
	EU	67,7	67,8	64,8	62,6	63,6
	NAFTA	55,7	55,7	48,7	50,4	50,2
XintraICT	APTA	22,0	27,6	24,6	23,2	23,3
	ASEAN	29,0	25,0	23,1	23,2	23,0
	EU	11,4	8,8	6,3	5,2	5,3
	NAFTA	17,3	12,3	10,5	9,3	9,4
FDI	APTA	101,9	159,5	334,5	580,8	635,8
	ASEAN	491,0	772,6	1918,8	2862,0	2922,5
	EU	4746,7	8777,0	14542,3	15307,3	15015,2
	NAFTA	7720,8	8435,7	10335,1	14089,6	15968,1
GDP	APTA	904	1 531	3 189	5 104	5 122
	ASEAN	1 188	1 707	3 316	3 864	3 990
	EU	18 208	29 011	33 596	32 211	32 316
	NAFTA	28 201	34 620	38 224	43 139	43 563

TABLE III.   DYNAMICS OF INDICATORS OF THE EXTERNAL COMPONENT OF THE INTERGRATION PROCESSES POTENTIAL

Integration association indicator		2000	2005	2010	2015	2016
d_{ITj}	APTA	7,4	11,1	15,0	18,8	18,1
	ASEAN	6,7	6,3	6,9	7,0	7,2
	EU	38,0	38,8	33,9	32,6	33,6
	NAFTA	19,0	14,1	12,8	13,9	13,8
d_{GDPj}	APTA	6,8	8,6	13,6	20,1	20,1
	ASEAN	1,9	2,0	3,0	3,3	3,4
	EU	26,5	30,3	25,8	22,0	21,8
	NAFTA	35,1	32,0	26,9	28,0	28,2
d_{FDIj}	APTA	3,5	3,7	4,7	6,8	7,1
	ASEAN	3,4	3,8	5,7	7,2	7,0
	EU	31,0	38,2	36,3	31,0	28,7
	NAFTA	43,1	32,4	23,7	27,2	29,3
d_{Nj}	APTA	41,3	41,0	40,5	39,9	39,8
	ASEAN	8,5	8,6	8,6	8,6	8,6
	EU	8,0	7,6	7,3	6,9	6,8
	NAFTA	6,8	6,7	6,7	6,6	6,6
d_{XICTj}	APTA	10,44	24,52	32,72	37,07	35,07
	ASEAN	17,04	11,57	14,67	14,89	15,08
	EU	27,32	26,89	18,49	14,05	14,61
	NAFTA	21,25	13,87	11,94	10,90	10,95

The largest potential for the development of integration processes, which has a tendency to gradually increase, is inherent in the EU (0,596 in 2016). NAFTA has a rather high index (0,501 in 2016). For APTA countries, the general integral indicator of the potential for the development of integration processes has a tendency to increase (from 0,126 in 2000 up to 0,356 in 2016). For calculations the UNCTAD statistical database was used, the integral indicators of the integration processes development potential are presented in Fig. 1.

From the point of view of the functional aspects of the emergence of integration ties (production integration, trade integration, market integration) the highest level of development of integration cooperation is characterized by the EU, NAFTA, APTA compared with the other integration associations (Fig. 2).
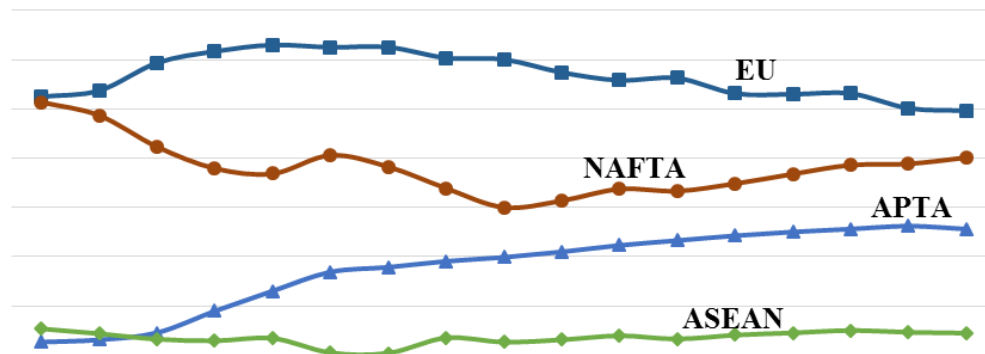
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
APTA	0,126	0,131	0,145	0,189	0,230	0,268	0,278	0,290	0,298	0,309	0,323	0,332	0,342	0,350	0,356	0,362	0,356
ASEAN	0,153	0,143	0,132	0,129	0,134	0,104	0,104	0,135	0,126	0,131	0,139	0,132	0,140	0,145	0,150	0,146	0,144
EU	0,625	0,637	0,693	0,717	0,729	0,725	0,725	0,703	0,700	0,674	0,658	0,662	0,631	0,630	0,631	0,601	0,596
NAFTA	0,613	0,586	0,523	0,479	0,468	0,505	0,482	0,439	0,400	0,413	0,437	0,433	0,448	0,467	0,485	0,488	0,501

Figure 1.   Integral index of the integration development potential

In order to carry out an experimental assessment of possible effects from the integration interaction development (through the example of the EU countries and the USA), economic and mathematical models of dependence of socio-economic development levels of countries on the enhancing of cooperation were drawn up, the estimated GDP values were calculated, the effectiveness of deepening cooperation between the US and EU countries was evaluated. Evaluation of the effects of deepening integration cooperation revealed a positive effect (the relative increase in total per capita GDP is 9.62% (according to forecast calculations for 2020), determining the effectiveness and feasibility of deepening integration cooperation.

IV.   CONCLUSION

Thus, the proposed approaches of modeling the multidimensional indicators of regional integration processes development and the assessment of the effects from the deepening of integration cooperation, based on the system of economic and mathematical models and their statistical analysis tools, can form the basis of the methodology for assessing the effectiveness of interregional integration cooperation, which allows to develop the economic effects of interaction on the following levels: country-country, country-association, country-region, region-region, association-association. The application of these approaches allows to identify potentially attractive vectors of cooperation and deepen cooperation in different fields (industrial, scientific and technical, trade, financial integration, etc.).
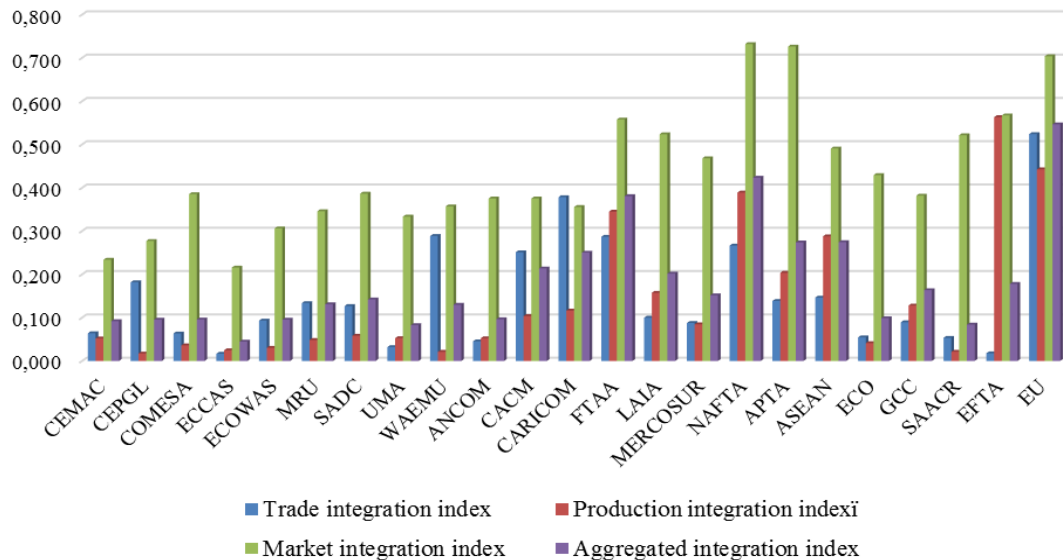
Figure 2. Aggregated integration index (2013)

In order to assess the integration processes development potential, it is expedient to employ integral indicators, the usage of which allows to obtain a generalized complex and quantitative description of regional integration processes that occur in the world economy at a certain period of time.

Integration processes as the focus of the research require continuous monitoring in terms of their indicators as well as the utmost complete synthesis of the tools for quantitative analysis and assessment, among which one may stress the static analysis methods as they are relatively simple in terms of technical aspects of implementation on the one hand, and rather analytically spacious and informative on the other hand, particular attention is worth paying to methods of multi-dimensional evaluation and scaling, and methods of economic and mathematical modeling.

REFERENCES

[1]   P. Lombaerde, G. Pietrangeli, C. Weeratunge, "Systems of indicators for monitoring regional integration processes: Where do we stand?," *The Integrated Assessment Journal*, vol. 8, issue 2, pp. 39-67, 2008.

[2]   P. Lombaerde, l. Iapadre, A. McCranie, L.Tajoli "Using Network Analysis To Study Globalization, Regionalization, And Multi-Polarity—Introduction To Special Section», *Cambridge University Press. Network Science*, 6 (4), 2019, pp. 494–516.

[3]   L. Guiso, H. Herrera, M Morelli, "Cultural Differences and Institutional Integration", *Journal of International Economics*, vol. 99, 2016, pp. 97-113.

[4]   C.-Y. Park, R. Claveria, "Does regional integration matter for inclusive growth? Evidence from the multidimensional regional integration index", *ADB Economics Working Paper Series*, No. 559, 2018, 62 p.

[5]   A. Akbari, L.K. Ng, B.Solnik, "Emerging Markets Are Catching Up: Economic or Financial Integration?", *Journal of Financial and Quantitative Analysis,* 2019. URL: http://dx.doi.org/10.2139/ssrn.3024192

[6]   R. McDougall, "Regional Trade Agreement Dispute Settlement Mechanisms: Modes, Challenges and Options for Effective Dispute Resolution", RTA Exchange.Geneva: International Centre for Trade and Sustainable Development (ICTSD) and the Inter-American Development Bank (IDB), 2018, URL: www.rtaexchange.org/.

[7]   S. W. Schill, G.Vidigal, "Reforming Dispute Settlement in Trade: The Contribution of Mega-Regionals", RTA Exchange. Geneva: International Centre for Trade and Sustainable Development (ICTSD) and the Inter-American Development Bank (IDB) , 2018, URL: www.rtaexchange.org/.

[8]   Br. Russett, H. Starr, D. Kinsella, "World Politics: The Menu for Choice", Cengage Learning, Wadsworth: Cengage Learning, 2009, 552 p.

[9]   R. Baldwin, J. Lopez-Gonzales, "Supply-Chain Trade: A Portrait of Global Patterns and Several Testable Hypotheses," *World Economy*, 38 (11), 2015, pp. 1682–1721.

[10] V. Aggarwal, S. Evenett, "A Fragmenting Global Economy: A Weakened WTO, Mega-FTAs, and Murky Protectionism", *Swiss Political Science Review*, 19, 2013, pp. 550–557.

[11] J. König, "The EU Index of Integration Effort", Indicator-Based Monitoring of Regional Economic Integration, Springer, 2017, pp..73-94.

[12] S. Becker, P. Egger, M. Von Ehrlich, "Effects of EU Regional Policy: 1989-2013", Regional Science and Urban Economics, Vol. 69, 2018, pp. 143-152

[13] T.W. Anderson "An Introduction to Multivariate Statistical Analysis" 3rd ed. Hoboken, NJ: John Wiley & Sons, 2003, 742 pp.

[14] H.-S. Huh, C.-Y. Park "Asia-Pacific Regional Integration Index: Construction, Interpretation, and Comparison", *ADB Economics Working Paper Series*, No. 511, 2017, 35 p.

[15] O. Bulatova, Y. Chentukov, I. Chentukov, "Integration Processes and Global Region", *Journal of European Economy*, Vol. 17, No 3, 2018, pp. 292–304.

[16] E. Diewert, "Irving Fisher And Index Number Theory," *Journal of the History of Economic Thought*, Cambridge University Press, vol. 35(02), 2013, pp. 199-232

[17] D. A. Freedman, "Statistical Models. Theory and Practice", 2nd ed., Cambridge University Press, 2009, 458 pp.

[18] I. Tinbergen, "Shaping the World Economy; Suggestions for an International Economic Policy", Twentieth Century Fund, New York, 1962, URL http://hdl.handle.net/1765/16826

[19] O. Zakharova, "Assessment of countries and regions integration interaction features" *Bulletin of Mariupol State University Series: Economics,* Vol.10, 2015, pp. 95-103 (in Ukrainian)