РОЗВИТОК РЕГІОНІВ, ГАЛУЗЕЙ ТА ВИДІВ ЕКОНОМІЧНОЇ ДІЯЛЬНОСТІ

DEVELOPMENT OF REGIONS, INDUSTRIES AND TYPES OF ECONOMIC ACTIVITY

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ASSESSMENT OF THE STRUCTURAL CHANGES UNDER TRANSITION OF UKRAINE TOWARDS POSTINDUSTRIAL ECONOMY

The purpose of this study is to assess the structural changes in the national economy of Ukraine, the countries of the European Union, the USA and the Republic of Bilorus, which is supposed to be implemented through the use of an integrated indicator of the assessment of structural changes in the sectoral structure of GDP; in determining the weighting factors and making up the latter the principle of «golden ratio» is used. The choice of components of the integral indicator for structural changes is due to the sectoral division of GDP into industry, agriculture and services. The proposed integral indicator reflects the harmonious (ideal) GDP structure peculiar to the post-industrial economy, while deviations in the real structure indicate structural changes in the national economy of Ukraine, the European Union, the USA and the Republic of Bilorus. The article presents the results of the calculation of the integral indicator of structural changes in the sectoral structure of GDP and its structural elements. Besides, the article provides analysis of the reasons for the deviations of real indicators from the harmonious ones. The calculations show the crisis phenomena both in the Ukrainian economy and in the EU, the USA and the Republic of Belarus.

The domestic economy demonstrates significant deviations in virtually all sectors, indicating a low level of economy, a mismatch between supply and demand in the labor market, a low level of innovation, and the inertia of transformational processes within the transition to the post-industrial stage of production. The

application of the proposed methodology will allow us to identify strategic directions for the development of national economy sectors and develop forecast scenarios.

Keywords: three-sector model; structural changes; integral indicator; harmony; golden ratio; postindustrial economy; ideal structure; GDP structure.

Introduction. Under current conditions of transition of the Ukrainian economy from the industrial to the post-industrial stage of development, structural shifts are taking place, which scientists-economists considerto be as follows: changes that cause qualitative transformation of the economic system, expressed in quantitative terms [1], as well as changes in the product-sectoral structure of the economy within production and consumed resources: investments and basic fund (industrial, technological, developmental and other structures), labor, material and energy resources [2].

That is, under structural changes qualitative transformation in the economy are considered, accompanied by changes in its industrial structure, the structure of the fund, labor, technological structure. The study offers to consider structural transformation based on the classic sector model basing on technological criterion as determined by the specific correlation of sectors and highlights the superior ones on a particular stage of socio-economic development and economic system [3]. The study of structural transformations in the sectoral structure of the economy will reveal the priorities and directions of public policy for investing in certain sectors of the economy in order to ensure the sustainable development of the country as a whole.

Literature review. Based on the achievements of such researchers as V. Heiets and L. Shynkaruk [2], A. Chukhno [3], L. Serhieieva [4], V. Inozemtsev [5], it should be noted that in the post-industrial society the dominant role is played by the services sector, and the production sector (primary sector is agriculture and secondary sector is industry) has a small share.

In the works of foreign researchers various aspects of structural change are studied, so E. Bah [6] proposed a model of structural transformation, using it to construct the industry time series of the indicator of general productivity factors in accordance with the redistribution of labor between the three sectors (agriculture, industry and services) and GDP growth per capita. In the work [7], the authors, based on the theory of three sectors and the work of A. Lefevre, «The Urban Revolution», propose a four-sector model in which the service sector is replaced by sectors focused on urbanization and control.

W. Zang [8] offers a model for the growth of a small open economy and distinguishes three sectors – industry, services and housing. The offered model synthesizes four models of neoclassical growth theory and the urban economy – the low growth model, the two-sector model by Uzavi, the urban model by Alonso and the housing model by Mood. The author analyses the dynamics of the influence of such parameters as interest rate and internal advantages of the country's economy on the economic structure, labor markets, fund, land and housing, the price of goods and services.

A team of researchers [9] analyzed the three-sector model of the economy with a focus on the labor market, a feature of which is the use of the endogenous subsidy on full employment. They point out that adjusting the endogenous subsidy for the difference in wages equals wages in a market economy. Full employment can be achieved provided that the marginal products of the two sectors are equal to the subsistence level. So, a significant reduction in the subsistence level is a necessary and sufficient prerequisite for obtaining full employment in a three-sector economy.

Muro Kazunobu [10], based on the theory of the three sectors of economic model, examines the basic factors of production (land, fund, labor power) within the trajectory of continuous development (CGP), where rent rate remains constant, is used to coordinate Kaldora and Kuznets factors, plays a certain role in linking the wage rate and the rent rate in the three-sector model. But the author proves that the dynamic system along the CGP in the three-branch three-factor model corresponds to the standard two-sector optimal growth model.

L. Serhieieva justifies the approach to estimating structural changes in national economies on the basis of harmony, when the services sector is given a share of 62%, industry – 24%, and agriculture – 14% [4]. The team of authors [11] offers a methodology for assessing structural shifts in the national economy, based on the principles of mathematics of harmony and taking into account the sectoral model of GDP structure.

Based on the above approaches, in order to estimate structural changes we will use the GDP indicator by type of economic activity, based on the sectoral structure and affiliation of a particular industry to a particular sector of the economy – agriculture, industry and services, also we will use the rules of harmonization in constructing an integral indicator of structural changes.

The purpose of the article is to identify structural changes in the economy of Ukraine and to compare the tendencies of development in its sectors with the countries of the European Union, the USA and the Republic of Belarus.

Results and discussion. Authors offer the following structure of an indicator of evaluation of structural changes according to the three-sector model, where the main coefficients are determined in accordance with the rules of harmony, mainly the golden ratio:

$$S_{GDP} = |0,62 - S_{Serv}| + |0,24 - S_{Ind}| + |0,14 - S_{Agr}|, \tag{1}$$

where S_{GDP} is the value of the integral index ($0 < S_{GDP} < 1$); S_{Serv} – share of the services sector in GDP; S_{Ind} – share of industry in GDP; S_{Agr} – share of agriculture in GDP.

Having analyzed the structure of GDP according to the three-sector model, it can be stated that it is not harmonious across the countries under study (Table 1).

Table 1

The structure GDP in Ukraine, countries of the EU, the Republic of Belarus b and the USA 2010-2018 according to the three-sector model

Years	Ukraine			EU countries			USA			Republic of Belarus		
	Serv	Ind	Agr	Serv	Ind	Agr	Serv	Ind	Agr	Serv	Ind	Agr
2010	0.6600	0.2558	0.0842	0.6724	0.3125	0.0151	0.7604	0.1978	0.0114	0.6022	0.2965	0.1013
2011	0.6496	0.2555	0.0949	0.6668	0.3174	0.0158	0.7550	0.2000	0.0132	0.5741	0.3352	0.0907
2012	0.6575	0.2520	0.0905	0.6689	0.3153	0.0157	0.7574	0.1991	0.0120	0.5773	0.3300	0.0927
2013	0.6697	0.2300	0.1003	0.6703	0.3134	0.0163	0.7533	0.02007	0.0138	0.6295	0.2932	0.0773
2014	0.6482	0.2352	0.1165	0.6689	0.3152	0.0159	0.7535	0.2023	0.0122	0.6339	0.2834	0.0827
2015	0.6253	0.2327	0.1419	0.6621	0.3227	0.0152	0.7634	0.1944	0.0107	0.5238	0.3801	0.0961
2016	0.6119	0.2498	0.1382	0.6608	0.3244	0.0148	0.7702	0.1888	0.0101	0.6275	0.2926	0.0798
2017	0.6282	0.2512	0.1206	0.6595	0.3249	0.0156	0.7900	0.1900	0.0200	0.6097	0.3031	0.0872
2018	0.6331	0.2473	0.1196	0.6592	0.3254	0.0154	0.7490	0.2070	0.0113	0.6201	0.3051	0.0748

Source: compiled and calculated by the authors according to [12-15].

Regarding Ukraine, the main problems in the development of the agro-industrial complex are the use of outdated technologies of land cultivation, low level of labor productivity due to the deindustrialization of agricultural production, rather low productivity of agricultural crops, over-employment, irrational production organization.

According to B. Danylyshyn, in order to remain competitive and develop dynamically, Ukrainian agriculture needs modern infrastructure, research and innovation. In particular, the expert speaks of three groups of innovations: organizational and technical (precise agriculture, M2M-solutions and «lean production»), financial-logistical and industrial innovations (formation of peering credit system and platforms for e-commerce) [16].

Concerning the deviations of GDP structure in the industrial sector of Ukraine, it should be noted that these structural changes are the result of, firstly, the inefficient functioning of the low-

key production (the share of V structure in Ukraine is less than 5% of total production), and secondly, the result of the use of outdated technologies and equipment in water supply and sewerage system, this area needs re-equipment and renewal; thirdly, the result of the problems in highly sophisticated areas where highly qualified specialists of nano and molecular technologies migrate abroad and finally the result of dequalification of the staff in most sectors, loss (essential narrowing) of industrial sphere in the national industrial – agrarian economy.

As for the tertiary sector, services such as commerce are moving from the classic model to e-commerce, and therefore require completely different resources: they no longer need the retail space, but the Internet platform, not the sellers, but the universal consultants (which may be replaced by custom programs in the future), they are also in need of logistics specialists (to develop optimal routes of delivery of goods with the aim of reducing overhead costs), site developers and visualization specialists, targetologists, etc. That is, the prospect of development of the services sector is to diversify the ways of their provision with the use of modern information technologies, mobile applications, cloud technologies etc.

A common trend in the EU and USA is the large deviations in the agricultural sector, which is explained by the transformation of the primary sector into the secondary, and in greater part, into the tertiary one. Such distribution, to our mind, is connected with the necessity of solving the problem of food security through genetic modification, with the necessity of application of modern bioengineering and molecular technologies in the production of products in this industry, which has led to a shift of emphasis in filling the GDP.

In the USA the sustainable trend is prevailing the services sector in the GDP (75-79%), indicating the transition of industry towards V-VI structures, which are directly related to the development of nanoenergy, molecular-, cell- and nanotechnology, nanobionics, constructing robots and devices, biomedicine, biocomputer systems, i.e the development of artificial intelligence interacting with organic, «live» systems.

So, postindustrial revolution in the USA identified new proportions in the national economy and trade – economic hierarchy. Management, marketing, advertising, tracking the goods to the buyer, e-commerce, virtualization of business, appearance of cryptocurrency has replaced material production (industrial and agricultural products) in the hierarchy of American economy. The change of the value equivalents (and accordingly the price equivalents) in the market has identified the phenomenon of «new» digital economy, a key feature of which is dematerialization (virtualization, digitalisation) of economic system of the society.

The most close to harmonious is the GDP structure of the Republic of Belarus, which, to our mind, is explained by the «manual» management of the economy and state protectionism.

Indicators of deviation of the real GDP structure of the studied countries according to the three-sector model from the ideal ones, which have a structure based on the «golden ratio» principle (formula 1), are presented in figures 1-4.

Exploring the S_{Agr} sector of Ukraine (Fig. 1a), it should be noted that the maximum deviation from the ideal structure is 0.0558 (5.58%) in 2010, the minimum – 0.0018 (0.18%) in 2016, the average deviation in structure is 0.0286 (2.86%).

In the sector S_{Ind} (Fig. 1b) the maximum deviation from the ideal structure is observed as 0.0158 (1.58%) in 2010, the minimum – by 0.0048 (0.483%) in 2014, the average deviation in structure – by 0.0104 (1.04%).

In the service sector (S_{Serv}) (Fig. 1c) the maximum deviation from the ideal structure is 0.0497 (4.97%) in 2013, the minimum – 0.0053 (0.53%) 2015, the average deviation across structure, – 0.0244 (2.44%).

Thus, the calculations made indicate the crisis phenomena in the socio-economic sphere in 2013-2015, which is explained by both political factors (annexation of territories, hybrid war) and globalization (absence of integration into international alliances, economic isolation in the international environment) and also by economic factors (long-term decline in external demand for domestic goods and services, massive outflow of fund and investments).
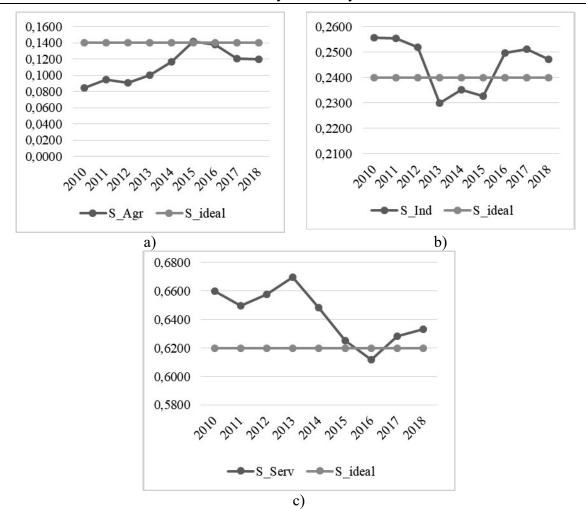
a)

b)

c)

**Fig. 1. Comparative dynamics of the ideal and estimated indicators of GDP
structure by sectors of economy in Ukraine during 2010-2018: a) Agr, b) Ind, c) Serv**
Source: calculated by the authors according to table 1.

While investigating the S_{Agr} sector in EU countries (Fig. 2a), it should be noted that the maximum deviation from the ideal structure is 0.1252 (12.52%) in 2016, the minimum − 0.1237 (12.37%) in 2013, the average deviation in structure is 0.1245 (12.45%).

In the industrial sector and S_{Ind} (Fig. 2b), the maximum deviation from the ideal structure is 0.0854 (8.54%) in 2018, the minimum − 0.0725 (7.25%) in 2010, the average deviation in structure, − 0.0790 (7.9%).

Exploring S_{Serv} sector in EU countries (Fig. 2c), it should be noted that the maximum deviation from the ideal structure is 0.0524 (5.24%) in 2010, the minimum − 0.0392 (3.92%) 2018, the average deviation in structure − 0.0455 (4.55%).

Thus, as shown in Figure 2, the first two sectors show a straight-line trend in the development of agriculture and industry, and the services sector is gradually approaching its ideal value. This situation shows the transformational changes in the economies of the EU countries, when the EU's policy is gradually being implemented towards overcoming the debt crisis, eliminating the imbalances in the budget, in trade and in the movement of the fund, towards mobilizing the loans. Most EU countries have labour shortage, for example, the German labor market requires up to 1 million people with vocational education and specialization, and Poland overlooks its shortage of professionals through an open policy of attracting migrant workers from Ukraine, Belarus, Georgia and some Asian countries.
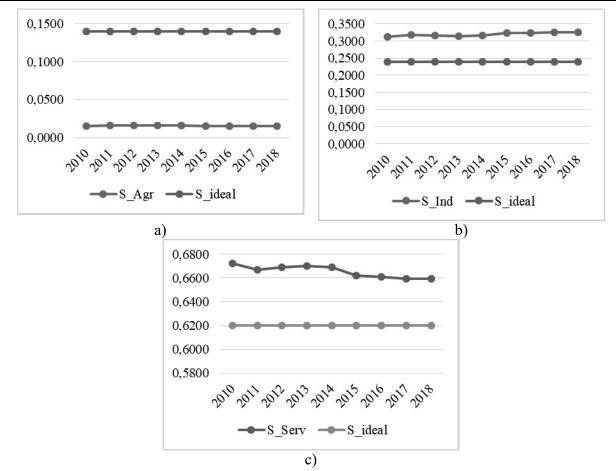
a)

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Fig. 2. Comparative dynamics of the ideal and estimated indicators of GDP structure by sectors of economy in EU countries during 2010-2018: a) Agr, b) Ind, c) Serv
Source: calculated by the authors according to table 1.

Having carried out the research of the agricultural sector S_{Agr} in the USA (Fig. 3a), it should be noted that the maximum deviation from the ideal structure is 0.1303 (13.03%) in 2017, the minimum − 0.1262 (12.62%) in 2013, the average deviation in structure is 0.1294 (12.84%).

Regarding S_{Ind} sector (Fig. 3b), it should be noted that the maximum deviation from the ideal structure is 0.0512 (5.12%) in 2016, the minimum − 0.0330 (3.30%) in 2018, the average deviation in structure is 0.0404 (4.04%).

Exploring S_{Serv} sector in the USA (Fig. 3), it should be noted that the maximum deviation from the ideal structure is 0.1502 (15.02%) in 2016, the minimum − 0.1290 (12.9%) in 2018, the average deviation in structure is 0.1371 (13.71%).

The services sector is dominant in the structure of GDP in the USA, as there is a decline in traditional industrial industries such as automotive, aviation, while the areas of circulation, maintenance, IT technologies are gaining pace. The production of computers, software, processors, multimedia tools, development, maintenance and improvement of Internet communications, digitalization of the economy and society has led to the growth of the three key areas of post-industrial economy of the United States – wholesale, retail trade and banking sector.

Thus it may be pointed out that computerization (digitalization) of the socio-economic life is the tool for distribution, circulation, service maintenance of material production. Industry, agriculture and transport traditionally depend on energy, human resources, political and geopolitical factors, while the service sector is virtualized, thus accelerating the trade and calculation operations.
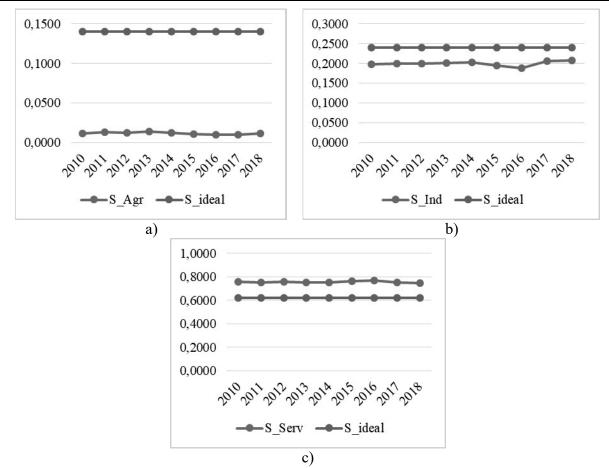
a)

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Fig. 3. Comparative dynamics of the ideal and estimated indicators of GDP structure by sectors of economy in the USA during 2010-2018: a) Agr, b) Ind, c) Serv
Source: calculated by the authors according to table 1.

In the agro-industrial sector S_{Agr} of the Republic of Belarus (Fig. 4a) the maximum deviation from the ideal structure is observed as 0.0558 (5.58%) in 2010, the minimum − 0.0018 (0.18%) in 2016, the average deviation in structure − 0.0286 (2.86%).

Industry Sector S_{Ind} (Fig. 4b) shows the maximum deviation from the ideal structure to be 0.0652 (6.52%) in 2018, the minimum − 0.0387 (3.87%) in 2010, the average deviation of structure − 0.0530 (5.3%).

As for S_{Serv} sector (Fig. 4c), the maximum deviation from the ideal structure is 0.0962 (9.62%) in 2015, the minimum − 0.0001 (0.01%) in 2018, the average deviation in structure , − 0.0271 (2.71%).

Analyzing the above GDP structure, it should be noted that the state policy of the Republic of Belarus is aimed at industrialization, since the industrial sector accounts for 30% up to 85% of Belarusian export in the structure of GDP. The main industrial giants are «Minsk Tractor Works», «Minsk Automobile Plant», «Mogilev Automobile Plant», «Gomel Plant of Agricultural Engineering», «Minsk plant of wheel tractors», «Belarus car plant», oil refining plants in Novopolotsk («Naftan») and in Mozyr («Mozyrskyi oil refining plant»), «Belarusian metallurgical plant» in Zhodino, «Belaruskaliy», «Grodno Azot», «Bilenerho», «Beltransgaz» («Gazprom Transgaz Belarus»), «Atlant». There are a number of state programs in the republic to support the development of the industry, thanks to which enterprises have state subsidies, benefits and priorities in investing.

The agro-industrial complex provides domestic needs for foodstuffs by more than 80%, and only about 17% of the total food consumption is imported (mainly fish and tropical products). Such a balance of food resources is sufficient to strengthen the country's food security. The government has implemented a program for rural regeneration and development, helping to form new types of rural settlements – agro-towns the number of which is more then a thousand and a half.
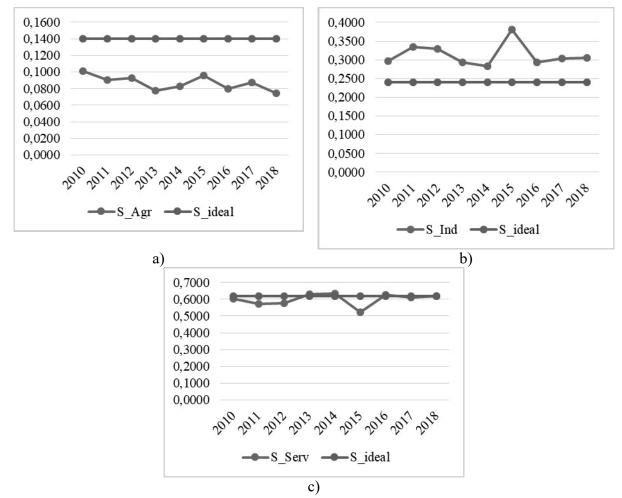
a)

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Fig. 4. Comparative dynamics of ideal and estimated values of GDP structure by sectors of economy in the Republic of Belarus during 2010-2018: a) Agr, b) Ind, a) Serv
Source: calculated by the authors according to table 1.

Alexander Lukashenko's decree number 8 «On the development of the digital economy» came into force on March, 18 2018; it legalized cryptocurrency in the country, Bitcoin in particular, ICO and smart contracts. The country is attractive for outsourcing – remote software development, for example, Viaden Media is a software developer for All-in Fitness, Smart Alarm Clock and Yoga.com for iPhone and iPad. All-in Fitness has been a front runner for a long time in more than 40 countries in Healthcare & Fitness section in AppStore. The total number of application usage exceeded 200 million, by 2011 the company itself has become the largest mobile app developer in the post-Soviet space. In 2016, Facebook bought Masquerade (MSQRD), an application of Belarussian developers, Masquerade Technologies for photo and video overlays of masks and filters; in 2017 Google bought Belarussian company AIMatter, which specializes in computer vision [17]. Therefore, the country's services sector has the closest possible structure to the ideal one.

Applying formula (1) the authors made calculations of integral indicators of structural changes during 2010-2018 in Ukraine, EU countries, the USA and Respublic of Belarus (Table 2).

Each of the studied country and their alliances show a positive trend towards achieving an ideal GDP structure, but the mechanisms of transformation of the sectors are different for each of the economies.

Table 2

Integral index S_{GDP} for Ukraine, EU, USA, Belarus

Years	Integral index S_{GDP} for Ukraine	Integrated index S_{GDP} for EU countries	Integral Index S_{GDP} for the USA	Integral index S_{GDP} for the Republic of Belarus
2010	0.1116	0.2497	0.3112	0.1130
2011	0.0902	0.2484	0.6042	0.1903
2012	0.0990	0.2486	0.6043	0.1801
2013	0.0995	0.2475	0.6037	0.1255
2014	0.0565	0.2482	0.6041	0.1146
2015	0.0146	0.2496	0.6048	0.2802
2016	0.0196	0.2504	0.6052	0.1203
2017	0.0387	0.2488	0.6044	0.1262
2018	0.0408	0.2493	0.2907	0.1304

Source: calculated by the authors.

Thus, in the post-industrial economy, globalizational transformations and informatization of the society, firstly, the nature of work (where intellectualization and the ability to work with significant amounts of information) is changing significantly, and secondly, the division of production activity by sectoral principle, on the basis of which a fundamentally new intellectual and creative sector is formed, and thirdly, there is a change towards satisfaction of needs from material to cultural and personal, and, consequently, the change in the human motivational complex.

As a result of these processes, structural changes in the economy are observed, which in turn requires the introduction of a methodology for assessing structural changes in order to reduce their negative impact, develop scenarios for the development of the national economy and satify its needs with highly qualified specialists.

Conclusions. The approach offered by the authors concerning building the integrated index and evaluating structural changes in the sectoral structure of GDP, which is built on the proportion of «golden ratio», will allow the national authorities to determine the strategic directions of development of perspective sectors and to develop prognostic scenarios by calculating the deviation of some objective indicators.

The prospect of further research is to improve the methodology of evaluation of structural changes in the national system of training highly qualified specialists in order to ensure the growth in GDP; another prospect is to identify deviations between the future labour market demand and the existing structure of higher education in order to define the strategic directions of development and implementation of new educational programs.

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ОЦІНЮВАННЯ СТРУКТУРНИХ ЗРУШЕНЬ В УМОВАХ ПЕРЕХОДУ УКРАЇНИ ДО ПОСТІНДУСТРІАЛЬНОЇ ЕКОНОМІКИ

Проблема. В процесі переходу економіки України до постіндустріальної економіки відбуваються структурні зрушення, тобто такі якісні трансформації, що супроводжуються зміною галузевої структури, технологічного укладу та основних факторів виробництва. Тому необхідною є розробка інтегрального показника оцінювання структурних зрушень в секторальній моделі ВВП з метою подальшого нівелювання структурних дисбалансів в національній економіці та розробки сценаріїв її розвитку.

Метою дослідження є виявлення структурних зрушень в національній економіці України та порівняння тенденцій розвитку її секторів із країнами Євросоюзу, США та Республіки Білорусь.

Методи дослідження. Теоретичним підґрунтям дослідження є вчення про особливості постіндустріальної стадії розвитку економіки щодо її секторального поділу, а також правила математики гармонії, а саме золотого перерізу.

Результати. Основними факторами, що привели до структурних зрушень в агропромисловому комплексі України, є застосування застарілих технологій обробки землі, низький рівень продуктивності праці внаслідок деіндустріалізації аграрного виробництва, низька врожайність сільгоспкультур, надлишкова зайнятість, нераціональна організація виробництва. Структурні зрушення по промисловому сектору є незначними, внаслідок, по перше, неефективного функціонування низькоукладних виробництв; по друге – використання застарілих технологій та обладнання в системі централізованого водопостачання та водовідведення; по третє – проблем кадрового забезпечення високоукладних галузей. Сфера послуг під впливом цифровізації переходить до класичної моделі ведення електронного бізнесу, що призводить до трансформаційних змін у забезпеченні її фахівцями та диверсифікації способів надання послуг. Загальною тенденцією в країнах ЄС та США є значні відхилення по сектору сільського господарства, що пояснюється трансформацією первинного сектору у вторинний, а більшою мірою і в третинний. По США сталим трендом є переважання сектору послуг в структурі ВВП (75-79%), що свідчить про перехід промисловості до V-VI укладів. Зміна вартісних та відповідно й цінових еквівалентів на ринку й визначило феномен «нової» цифрової економіки, ключовою характеристикою якої є дематеріалізація (віртуалізація, діджиталізація) економічної системи й суспільства. Найбільш наближеною до гармонійної є структура ВВП Республіки Білорусь, що пояснюється «ручним» управлінням економікою, державним протекціонізмом щодо індустріалізації економіки та розвитку агропромислового комплексу. Країна є привабливою для аутсорсингу – віддаленого розроблення програмного забезпечення, тому сектор послуг має максимально наближену структуру до ідеальної.

Отже, кожна з досліджуваних країн та їх об'єднань демонструє позитивну динаміку щодо досягнення ідеальної структури ВВП, але при цьому механізми трансформації секторів відрізняються окремо для кожної з економік.

Наукова новизна. Наукова новизна полягає в обґрунтуванні будови інтегрального показника оцінювання структурних зрушень в економіці, виходячи із засад теорії гармонійності. Такий підхід, на відміну від існуючих, дозволяє порівнювати тренди розвитку постіндустріальних економік країн світу та розробляти прогнозні сценарії розвитку як окремих галузей, так і загалом всієї економічної системи.

Висновки. За результатами проведених розрахунків інтегрального показника структурних зрушень для досліджуваних країн, слід зауважити, що їх структура ВВП не відповідає гармонійній, спостерігаються відхилення за всіма секторами, що обумовлено особливостями державної економічної політики, векторним розвитком певних галузей та впливом різних політичних, соціальних, ментальних факторів.

Ключові слова: трисекторна модель; структурні зрушення; інтегральний показник; гармонійність; золотий переріз; постіндустріальна економіка; ідеальна структура; структура ВВП.