Modeling Structural Changes In The Industry And Their Impact On Financial Policy

Olena Horokhova, Halyna Chmeruk, Oksana Storozhenko, Vitaliy Romanchukevych, Larisa Gromozdova

Abstract—The dynamics of the structural changes in the impact of the five factors on the gross value added formation by economic activity of the industry are calculated in the dynamics, which is the basis for a detailed analysis of the six-sector economic model. The purpose of the article is to find a comprehensive index of structural changes in the Ukrainian industry by calculating quantitative assessment of structural changes, which is the basis for a detailed analysis of the six-sector economic model in the plane of three main components: Mining and quarrying; Manufacturing; production and distribution of electricity, gas, steam and air conditioning supply. The object of the study is the processes of structural transformation of the six-sector economy model in the Ukrainian industry, which is investigated on the basis of the analysis of Gross Value Added. Calculated in dynamics Index of variable composition, which shows the growth rate average weighted values of gross value added by five factors and Index of fixed composition of rate change of the weighted average values for the current period without regard to the growth rate of factor. Impact factors in each sector of the economy have been identified, which determine the integrated value of the reliability of structural change as the weighted average of the assessment of the reliability of structural change in the industry. It is proved that improvement of the mechanism of budgetary compensation of the value-added tax, creation of an export-credit agency will have a stimulating influence on the development of export activity and will help to increase the confidence of foreign investors to domestic exporting enterprises, which is a prerequisite for the growth of the real economy in terms of the real economy.

Index Terms—Industry, Gross Value Added, aggregate index, structural shifts index, eigenvalue, expert comparisons.

1 INTRODUCTION

The importance of industry, its place and role in the modern world economy in the recent period have changed significantly. If in developing countries, it continues to play a leading role, then in developed postindustrial countries, the situation is different. Here the first place was the sphere of services, pushing the industry to the background. At the same time, the industry itself undergoes structural changes aimed at increasing the role of individual industries in the modern world economy. In the structure of the economy of Ukraine the industrial complex plays an important role. It forms logistical the basis of the national economy, provides its technical re-equipment, and also defines military-economic security, success market reforms and perspectives of postindustrial development of the country as a whole. One of the priorities of socio-economic reform in Ukraine is the modernization of the structure of the national economy and its growth. The transformational process of development of economy and society of Ukraine as country with market economy is constantly in progress. This process requires a qualitative analysis of factors that influence the formation of models of integration and competitiveness of Ukraine in the international space.

The study of the structure of Gross Value Added by type of economic activity allows you to develop a strategy to ensure stable economic growth, as well as to identify the main problems of development of the Ukrainian economy. Gross Value Added shows the level of production efficiency, and it shows the level of motivation of employees to productive work. Note that depreciation (the element of gross added cost) indicates the degree of equipment availability and the availability of its necessary equipment, advanced technologies. The basic picture of behavior of Gross Value Added of industry for investigated groups of years is almost identical. This is due of course with negative political and social situation in Ukraine last years. The next questions arise:

— Is this qualitative growth?
— Is it possible to find out the factors of influence?
— For which structural changes occurs this growth?

Among directions of researches of structural parameters of economy it is expedient to be stopped for description of structural changes of six-sectoral model of economy on the basis of analysis of Gross Value Added. At the same time, it is promising to study the basic methods of evaluation and quantitative assessment of structural changes, which will allow qualitative management of the process of structural changes in industry [1, 3, 20]. However, the study of the influence of factors on the formation of gross value added by the economic activity of industry and structural changes in the industry, which is the basis for a detailed analysis of the six-sector economic model, has not been sufficiently studied.

2 LITERATURE REVIEW

Theories and models that can be used to analyze the interaction of processes of development and improvement of the economic structure are central to the scientific discussions of experts today [22, 23]. In particular among them there is the theory of structural change, a new theory of economic growth, the theory of economic dynamics, the model of linear stages of growth and the neoclassical model are studied in [1]. Odotyuk [9] shows that given the technical progress “golden rule” is formulated as follows: for maximum indicators of consumption it is necessary that the pure marginal productivity of capital was equal to the growth rate of total production output. Thus, it

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is created a system national economy with well-defined causal relationships that stimulate the development of high-tech production in all sectors of the economy.

Shinkorenko [14] points out that recently the vector of external economic activity of Ukraine moves exactly aside the EU. According [2], this is explained by achievers of exercised integration model in Europe, a significant size of internal market, the opportunity to receive a substantial financial assistance and advanced technologies.

Pyrozhkov [13] and Sidorenko [16] noted that this approach allows to obtain the systemically agreed prediction of structural changes in the economy in the long term, which accumulates in itself analysis of changes in the structure of production linkages between reproductive sectors, industries, taking into account the balance of labor resources, production volumes, the accumulation of productive capital, in line with forecasts components of final consumption and exports.

Kryuchkova [4] emphasizes that effective integration of domestic economy in world can have a place only on condition of achievement of high level of general competitiveness of country, and also by share of products and services on internal and external markets. Innovations (technological, organizational, structural and institutional) that create competitive advantages of countries are the basic of modern competitiveness. According to [5, 17, 21], analysis of economic strategies, which must be directed at stimulating of innovative process, making of re-industrialization and increasing of export of commodities (first and foremost those which have a large share of value added), taking measures on providing of public support for innovative projects, creating of new research centers, shaping the positive conditions for the implementation of long-term investments is an urgent problem on present day.

Lin [7] emphasizes the importance of developing and increasing the share of manufacturing, which causes design changes in units with high levels of production productivity. In turn, a higher level of productivity requires greater added value.

Warwick [25] argues that quantitative characteristics of structural change are determined by analyzing the dispersion of growth rates. There is also an intensity of structural shifts in the form of the elasticity of growth in productivity of production. Havlik [3] presents methodological approaches to assessing structural change in industry based on correlation analysis using Spearman rank correlation. Proper evaluation of resource creation capabilities structure of the industrial complex with domination of segments of the fourth and subsequent technological forms are given in the work of Odotuyk [9, 10]. In a scientific paper, Lin [7] identified that to overcome crises and the country's focus on economic growth is possible only in countries characterized by innovative industrial structure. Westkämper in [28] emphasizes the role of state industrial policy in the field of industrial complex restructuring.

The authors Shynkaruk in [15] emphasize that qualitative structural changes in the industrial complex are connected with the development of high-tech types of economic activity, including export orientation, the fourth, fifth and sixth technological processes. In the scientific work [12], the factors of influence on innovative sectors of production that lead to structural changes in the technological structure of an industrial complex are analyzed. According to Zbarazska in [28], the structural transformation of the industrial complex is based on the concept of innovative neo-industrialization.

Researchers in [8, 18] analyze structural changes in the Serbian manufacturing industry, taking into account the share of employment and value added. On the basis of the analysis is an indicator of structural changes in the manufacturing industry, which makes it possible to determine the patterns of structural changes. Authors in [24] investigate structural changes in developing countries based on changes in employment and the transition from less intensive production to more.

Authors in [19] emphasize that in the context of globalization, production is distributed in global value chains that connect different regions of the world, that is, the shape of structural changes in industry is changing. Xianjia in [27] explores industry modernization in the face of changing industries and the transition of one industry to another. In our opinion, this creates the basis for the study of structural changes in industry in the context of changing industries. At the same time, in the face of the current challenges of stepping up European integration processes, deepening globalization processes and technological shifts do not sufficiently cover issues in the economic literature regarding the concept of structural modernization of the Ukrainian economy. In this context, the solution requires the development of new scientific approaches to measuring structural changes in the Ukrainian industry, which will increase the competitiveness of the state.

3 Methodology

The scientific methods, which were used for conducting the research, are the economic and calculation of the aggregate index of structural changes by types of economic activity of industry is presented. Coefficient analysis methods and expert methods are used for quantitative measurement. During the research, the following scientific methods were used the methods of statistics for finding the index of structural changes in industry, the mathematical methods of expert paired comparison of groups of factors. Methods of calculating the aggregate index of structural changes by types of economic activity of the industry were used for quantitative measurement. The model in the study is based on the principles of structural change theory. Mathematical methods of expert paired comparison of groups of factors that have a direct impact on the industry in terms of their importance have been applied. The Kylov method [6] found the maximum eigenvalue of symmetric matrices with inverted elements, which allows us to find, by means of the theory of random matrices, the quantitative value of each factor affecting structural changes in industry. Dynamics of innovation activity of enterprises by types of economic activity in industry is analyzed; average annual number of employees in industry; index of fixed capital of investments in industry; index of conditions of export-import investments and their weighted average indicators; variable composition, fixed assets indices and fixed assets indices. As a result of this methodology, a cumulative indicator of the structural changes in the impact of five factors on the formation of gross value added in industry has been found.

4 Results

Consider the industries that dominate gross value added (Fig. 1). (Source: compiled on the basis of http://www.ukrstat.gov.ua).
Let’s take into account dynamics three basic components of the next types of economic activity of industry in Gross Value Added (at current prices; percent) in 2010-2017, Mining and quarrying, Manufacturing, production and distributing of Electricity, gas, steam and air conditioning supply, for the detailed analysis of structural changes to six-sectorial model of economy (Fig. 2).

Let us select the basic group of factors which influence on structural changes at forming of Gross Value Added in a cut three constituents of industry: Mining and quarrying, Manufacturing, production and distributing of Electricity, gas, steam and air conditioning supply (Fig. 3).

For measuring influence of factors of change of structural shifts on forming of gross value added we apply the methods of index factor analysis. Thus, it is possible to analyze structural changes in industry under act of five factors in the form of indexes of structural shifts on every factor.

The source data in accordance with Tables 1-3 about the impact factors on the change in the structure of Gross Value Added by economic activity in the industry in 2015-2017 are shown in Table 1.

**TABLE 1**

<table>
<thead>
<tr>
<th>Types of economic activity (industry)</th>
<th>Gross Value Added (min. UAH)</th>
<th>Amount of innovation active enterprises (percentage to the total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining and quarrying</td>
<td>95141</td>
<td>2015  131650  181317  9  9.3  10.1</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>236692</td>
<td>2016  291471  369452 19.5  21.1  18</td>
</tr>
<tr>
<td>Production and distributing of electricity, gas, steam...</td>
<td>53385</td>
<td>2017  73809  86740  10.5  11.4  8.9</td>
</tr>
</tbody>
</table>

We are interested in the issue the effect of changes in the average annual number of employees to change the structure of Gross Value Added of industry (Table 2). We use the index of the average annual number of employees.

**TABLE 2**
The source data on the average annual number of employees and the change of index of investment in fixed assets

<table>
<thead>
<tr>
<th>Types of economic activity (industry)</th>
<th>The average annual number of employees (thousands)</th>
<th>Index of investment in fixed assets (percent to the previous year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining and quarrying</td>
<td>255</td>
<td>73.9</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>1339</td>
<td>86.3</td>
</tr>
<tr>
<td>Production and distributing of</td>
<td></td>
<td>72.3</td>
</tr>
<tr>
<td>Electricity, gas, steam</td>
<td></td>
<td>90.8</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Let’s analyze the effect of direct investment in Ukraine by types of economic activity of industry. It is known that official NBU rates are used to transfer foreign currency to the national currency and vice versa. This procedure does not reflect the real ratio of purchasing power of foreign currencies and hryvnia. Therefore, there is a problem of complications of calculations of export and import efficiency indicators. Note that the application of cost includes only the current cost of production. And so, effectiveness of production costs depends on the index of export-import investment conditions – the ratio of direct investment from Ukraine to the other countries to direct investment in Ukraine. It is known that attracting investment in the state economy is more profitable than taking loans. However, factors affecting Ukraine, such as corruption, currency instability and inhibition of reforms, create inappropriate conditions for foreign investors. In 2017, the inflow of foreign direct investment fell more than doubled compared with 2016. In 2018, the situation has improved, Ukraine rises in the ranking of investment attractiveness of the countries of the world. The Verkhovna Rada of Ukraine has adopted a bill that simplifies the attraction of foreign investments. In recent years, the peak investment in Ukraine of foreign investment fell to 2011 ($ 6 billion). Over the past four years, the size of the investment in Ukraine has not come close to this level. FDI fell in 2014, when the political situation in the country was extremely unstable. Then the Ukrainian economy received only 2.5 billion dollars – 55% less than in 2013. However, in 2014, the volume of investments amounted to $ 3.8 billion – twice as much as in 2013. The inflow of foreign investments grew in 2016, and in 2017 there was a fall. In the first half of 2018, the inflow of foreign investment in Ukraine amounted to 1.3 billion dollars. Over the past two years, foreign investors have invested the most in financial and insurance activities, as well as wholesale and retail trade, repair of motor vehicles. This year investments came in the sphere of scientific and technical activity. It is known that Russia has invested in the Ukrainian economy 34.6% of the total volume of investments. The funds are also invested by Cyprus, the Netherlands, Austria, Poland, Great Britain, France, Germany, Italy and Hungary. The largest share in the structure of foreign direct investment falls on industrial enterprises. As of 01.01.2016, $ 13280.1 million is concentrated. The United States (30.6% of their total volume) of foreign direct investment, directed from the countries of the world into the domestic economy. The ratio of direct investments from Ukraine to the economy of other countries to direct investment in Ukraine by economic activity and the effect of the formation of prices of producers of industrial products on the structure of gross value added through the producer price index are represented in Table III. We used index analysis formulas (for example, Kevish, 1990) to calculate the indexes namely index variable composition, fixed composition and index of structural shifts for the factors discussed above at the periods 2015-2016 and 2016-2017. And so,

1) The weighted average values of gross value added which defined by five influence factors by the following formulas:

\[
\bar{x}_i = \frac{\sum_{j=1}^{3} p_{ij} q_j}{\sum_{j=1}^{3} q_j}, \quad \bar{x}_j = \frac{\sum_{i=1}^{3} p_{ij} q_i}{\sum_{i=1}^{3} q_i},
\]

where \(i\) – a number of the basic period 2015 (for the analysis of 2015-2016), and also a number of the basic period 2016 (for the analysis of 2016-2017); \(j\) – a number of the current period 2015 (for the analysis of 2015-2016), and also a number of the next period 2016 (for the analysis of 2016-2017);

2) Index of variable composition, which show the growth rate of average weighted values of gross value added by the abovementioned five factors

\[
I_x = \frac{\bar{x}_j}{\bar{x}_i} = \frac{\sum_{j=1}^{3} p_{ij} q_j}{\sum_{i=1}^{3} p_{ij} q_i} \cdot \frac{\sum_{j=1}^{3} q_j}{\sum_{j=1}^{3} q_j};
\]

3) Index of fixed composition of rate change of the weighted average values for the current period without regard the rate of growth of factor.
The structural changes for group 3 factors of direct influence on structural shifts in industry are presented in Table 2. In Table 2, the results of expert comparisons in the dynamics of the results of structural shifts for group 3 factors of direct influence on structural shifts in industry are presented in Table 3. The composition and structural shifts for group 2 factors of direct influence on structural shifts in industry are presented in Table 4. The results of calculations indices of the variable, fixed composition and structural shifts for group 3 factors of direct influence on structural shifts in industry are presented in Table 5.

4) Index of structural shifts, which show how much has changed indexed rate of factors of influence due to changes in the structure of gross value added:

\[
I_x = \frac{\sum_{i=1}^{3} p_i q_j}{\sum_{i=1}^{3} p_i q_j} ; \quad (3)
\]

Formulas of indexes of fixed composition and structural shifts is equally weighted, that provides connection between these indexes in the system

\[
I_x = I_x \cdot I_{sz} . \quad (5)
\]

Within the limits of index system we can determine the role of each factor, assess its influence on the dynamics of the result by factor analysis [11]. Next we find the weight value the importance of each factor by the method of Krylov [6] that will allow us to find the aggregate index of structural change taking into account the factors of influence the formation of GVA for some economic activities.

Indices were calculated by the formula (1)-(4) using the data Tables 1-3 separately for the periods 2015-2016 and 2016-2017. The results of calculations indices of the variable, fixed composition and structural shifts for group 3 factors of direct influence on structural shifts in industry are presented in Table 4.

<table>
<thead>
<tr>
<th>Appellation</th>
<th>I4</th>
<th>I5</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015-2016</td>
<td>1.27, 1.08</td>
<td>1.00, 0.99</td>
</tr>
<tr>
<td>2016</td>
<td>1.25, 1.08</td>
<td>1.00, 1.01</td>
</tr>
<tr>
<td>2017</td>
<td>1.29, 1.07</td>
<td>0.93, 1.10</td>
</tr>
<tr>
<td>2016</td>
<td>1.23, 1.08</td>
<td>1.01, 1.01</td>
</tr>
<tr>
<td>2017</td>
<td>1.30, 1.08</td>
<td>0.96, 1.02</td>
</tr>
</tbody>
</table>

There is an insignificant advantage of factor; 3 points – there is a significant advantage of factor; 4 points – there is a significant advantage of the factor; 5 points – there is an absolute advantage factor throughout all the assessment criteria. Group of experts has been involved for the calculation of pairwise comparison of factors groups of structural shifts on the degree of importance. If the first factor by expert estimates is regarded as an insignificant advantage of factor over the second, then this relation is estimated at 2 points, while the inverse relation advantages the second factor over the first will be estimated at 1/2 points. The results of expert comparisons are presented at a Fig. 4.
Data of the calculations expert assessments are presented by the next inverse-symmetric matrix (Table 6). By the method of Krylov [6] finding the eigenvalues of symmetric matrices with inverse element and detecting of the adequacy according to the method comparing of the theory of random matrices, we find the weight value the importance of each factor:

\[ v_1 = 0.153, \quad v_2 = 0.079, \quad v_3 = 0.389, \quad v_4 = 0.177, \quad v_5 = 0.202. \]

### TABLE 6
**MATRIX OF EXPERT PAIRWISE COMPARISONS OF INDICES I1, I2, I3, I4, I5**

<table>
<thead>
<tr>
<th></th>
<th>I1</th>
<th>I2</th>
<th>I3</th>
<th>I4</th>
<th>I5</th>
</tr>
</thead>
<tbody>
<tr>
<td>I1</td>
<td>1/2</td>
<td>1</td>
<td>1/3</td>
<td>3</td>
<td>1/4</td>
</tr>
<tr>
<td>I2</td>
<td>1/3</td>
<td>1/3</td>
<td>1/3</td>
<td>1/3</td>
<td>1/3</td>
</tr>
<tr>
<td>I3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>I4</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I5</td>
<td>1/3</td>
<td>1/2</td>
<td>1/2</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

The aggregate index of structural changes of influence of five factors on the formation of Gross Value Added by type of economic activity of industry, calculated by the formula

\[ I_\Sigma = \sum_{k=1}^{5} v_k I_{sz_k} \]

The results of calculations of the aggregate index are listed in Fig.5.

The total index of structural changes in the industry in 2017 has grown by 2.73 % in comparison with 2013. This is due to slight growth rates of Gross Value Added of the basic types of economic activity of Ukraine's industry the investigated period. Decrease of aggregate index of structural changes at the expense of 5 factors (table 5) suggests that in Ukraine the share of high-tech industries remains the not only too low, but also has acquired a downward trend. Particularly this situation is threatening the backlog development of extractive and processing types of activity in industry that on methodology of OECD form first two of the strategic sectors of the economy and today is one of the main factors of increase level of competitiveness and ensure sustainable dynamic growth of national economies.

### 5 DISCUSSION
Support for conditions of stable economic development, effective integration into the global economy, resilience to external risks is possible only in the presence of sound economic fundamentals - strong real and dynamic financial sector, effective economic policy. Industry development is driving economic growth in many countries around the world. In Ukraine there is no systematic approach on the vectors of industrial development. Therefore, materials for discussion on industrial development in Ukraine are presented: quantitative assessment of structural changes in industry, which can become one of the elements of the economic development strategy for the application of further innovation and technological modernization of the industry with the use of the investment component. This will contribute to the availability of financial resources and the deepening of production links. It is necessary to create a system of transformations in the industry based on a quantitative assessment of structural changes in the industry. This will eliminate fragmentation of industrial policy and thus coordinate industrial mechanisms. Therefore, analysis of the concept of structural change, as well as methods of assessing structural change in industry, will contribute to a systematic analytical approach of strategic vectors for the development of structural policy of Ukraine. The industry must be ahead of its development, accompanied by structural changes towards the growth of their particles both in the general issue of the manufacturing industry and in the economy as a whole. Despite the variety and depth of research, the problem of justifying and finding effective statistical methods of economic analysis to investigate the sources and consequences of systemic structural transformations to achieve successful implementation of structural and sectoral priorities remains relevant.
identify the instruments for their further development and to form a system of measures of state financial support. Improvement of the mechanism of budgetary compensation of value added tax, creation of an export-credit agency will have a stimulating influence on the development of export activity and will help to increase the confidence of foreign investors to domestic exporting enterprises, which is a prerequisite for the growth of real gross domestic economy.

REFERENCES