# Ukrainian economy development trends estimation based on the analysis of structural shifts

*Liudmyla* Serhieieva[1], *Galyna* Us[2], *Iia* Chudaieva[2], and *Olena* Makarenko[3,*]

[1]Zaporozhzhia State Medical University, Department of Medical Physics, Biophysics and Advanced Mathematics, 26 Mayakovsky prospect, Zaporozhzhia, 69000, Ukraine
[2]East European University of Economics and Management, 16 Nechuya-Levitskogo str., Cherkasy, 18036, Ukraine
[3]Zaporizhzhia National University, Department of Economic Cybernetics, 66 Zhukovskogo str., Zaporizhzhia, 69600, Ukraine

**Abstract.** The article elaborates upon development trends in the economy of Ukraine taking into account structural shifts. Herewith it is proposed a stagewise procedure for the analysis of development trends of the country's economy taking into account structural changes in industry and employment by sectors of economic activity. The authors present an indicator of structural shifts and evaluate efficiency of structural changes in the Ukrainian economy. In general, the structural shifts efficiency estimation shows that they are not effective in the Ukrainian economy, as the share of the services sector is increasing, while the productivity is growing more rapidly in the industry. The use of the presented analysis procedure will allow enhance efficiency of the strategies formulation of the country's economic development.

## 1 Introduction

Country's economy is a complex economic system (CES), which comprises interrelated elements with their own characteristics and exists for a certain purpose. There are ordered and established relations between the CES elements [1]. Since the CES functions within a time interval, then in the course of time it survives changes affected by the global economy's development, i.e. the economy change from industrial to postindustrial one leads to the change in the development priorities. A commonly recognized in the global economy is the division of economic activities into industry, agriculture, and services.

Economic activity is heterogeneous in its essence, for example, an implementation of modern technologies in manufacturing can increase the efficiency of production by reducing material costs. In construction, the use of modern technology can reduce the cost of the building and time for its development. Further, modern technologies implementation into the services sector will also lead to enhanced activity efficiency, but, for instance, by reducing the time of service provision.

Dynamics of the Ukrainian gross domestic product (GDP) structure by sectors of economic activity for the period from 2001 to 2017 is presented in Fig. 1.

According to the State Statistics Service of Ukraine [2], in 2001 industry (mining, processing industry, electricity, gas, water, construction) amounted to 33,7% of GDP, services sector – 50,6%, agriculture – 15,7%. In 2017, the Ukrainian GDP structure by sectors of economic activity changed, the share of services increased by 9,7%, the share of industry decreased by

6%, and the share of agriculture decreased by 3,6% as well. Consequently, in the period from 2001 to 2017, structural changes took place in the Ukrainian economy: the share of productive industry decreased, and the non-productive increased.
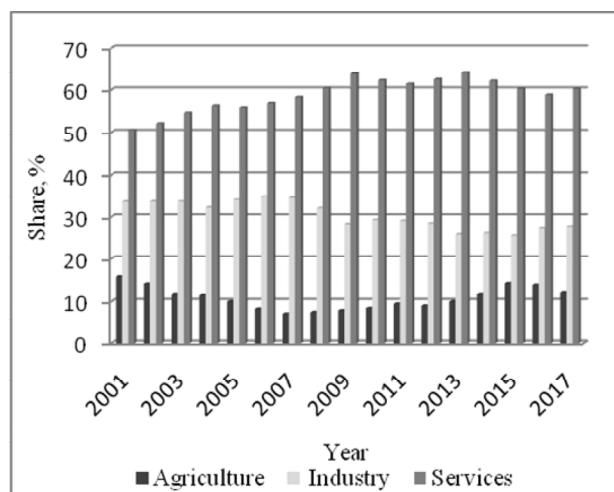


**Fig. 1.** Dynamics of the GDP structure by sectors of economic activity in Ukraine [2].

The same structural changes took place in other countries. Thus, in 2012, the share of agriculture in the Germany's GDP amounted to 0,87%, industry – 26,15%, services – 72,98%. In 2018, the share of agriculture in the GDP of Germany was 0,75%, industry – 25,8%, services – 73,45% [3]. In comparison with Germany the structural shifts in the Ukrainian economy demonstrate higher rates. However, the analysis of the dynamics of the structure of world GDP shows that this structure is

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stable and almost unchanged, for example, in 2009, in the structure of world GDP, the share of services ranged from 63,4%, industry – 30,6%, agriculture – 6 %. In 2017, the share of services was 63,6%, industry – 30%, agriculture – 6,4% [4].

According to the studies by O. Memedovik [5], the services sector has already started dominating in 1970 and accounted for 52% of world production, and in 2005 it reached 68%, the share of agriculture was 10% in 1970, in 2005 – 3,6%, the share of industry decreased from 38% to 29%. Consequently, structural changes in the global economy were subject to changes in the global economic development towards accelerated development of services.

The CES structure is the most inertial of its component. Researching the economic system structure change, that is, structural economic shifts, is an important scientific and empirical task, since the structure of a country's economy determines direction and efficiency of its development. Economy development trends evaluation based on the analysis of structural shifts should be carried out with the help of the methods of economic and mathematical modeling.

## 2 Analysis of the latest researches and publications

Structural changes in the economy have been studied by many researchers. With the change in economic structure, priority directions of the study of structural changes also changed. A. Smith believed that the level of economic development determines the structure of the economy. D. Ricardo considered that the required condition for the economy growth was the structural change of the manufacturing system. Structural changes in time, taking into account the importance of the various sectors, were researched by N. Chenery, M. Syrquin [6], Over time, the structure of the economy changes due to, for example, scientific and technological progress, which causes changes in production technology, which, in turn, affects the structure of employment and the structure of production in the spheres of economic activity. In addition, structural changes are also influenced by natural factors and urban processes (urbanization process). Thus, the presence of favorable natural resources allows us to develop those spheres of economic activity that use them: agriculture, industry.

A significant theoretical and practical contribution to the study of structural shifts in economic systems of various levels belongs to such scientists as V. Heyets [7], V. Galitsyn, V. Masliy, V. Ryabtsev, L. Serhieieva, V. Smal [8], and A Chukhno [9] and others. Despite the large number of scientific achievements, the issue of analyzing the trends in the development of the Ukrainian economy has not been highlighted properly, which makes this study significant.

The study of the structure of the country's economy, structural shifts and structural and functional relationships are based on the use of the structural analysis method. According to the definition of

academician V. Heyets "the subject of the structural analysis is the identification and explanation of the most significant internal elements, as well as their functional purposes in the context of the object studied, with the aim to model and then forecast development as the resultant action of fundamentally structural elements" [7]. The structural analysis allows to identify trends of the CES structure changes. The task of the CES structural analysis, namely the country's economy as a whole, is to determine the reasons for the system behavior, based on evaluation of the effectiveness of structural changes. By structural shifts we mean the change in the structure of the economic system in dynamics.

Despite a significant amount of research on the analysis of structural changes in the country's economy, estimation of trends in economic development based on the analysis of structural changes is not sufficiently considered in the scientific literature, which makes this research significant.

The purpose of the article is to study the development trends of the economy of Ukraine, taking into account the structural changes, and define indicators of the structural shifts.

## 3 Presentation of basic material of the research

The analysis of structural shifts in the economy of Ukraine is proposed to be carried out in several stages (Fig. 2).

In the first stage of the economic system structural shifts analysis, it is necessary, depending on the research purpose, select the system elements. Then define the list of economic parameters for the selected elements, which characterize them and analyze the dynamic of their change.

In the second stage, the analysis of structural changes is carried out, the interrelations between the selected indicators are determined.

In the third stage of the analysis of structural changes in a complex economic system, an estimation of the effectiveness of structural changes in terms of the impact on the performance of economic activities sectors is carried out.

The fourth stage focuses on structural changes forecast. When forecasting structural indicators of the development of the CES, it is advisable to apply the forecasting method proposed by Serhieieva [10] which is based on the related socioeconomic parameters.

The procedure for the CES structural shifts analysis procedure has been applied to analyze the structural changes the Ukrainian economy.

For the analysis, statistical data for the period from 2001 to 2017 [2] were used. As mentioned above, economic sectors are selected as elements of the system: industry, agriculture, and services. GDP by type of economic activity in actual prices and the number of employees in the relevant field of activity are selected as

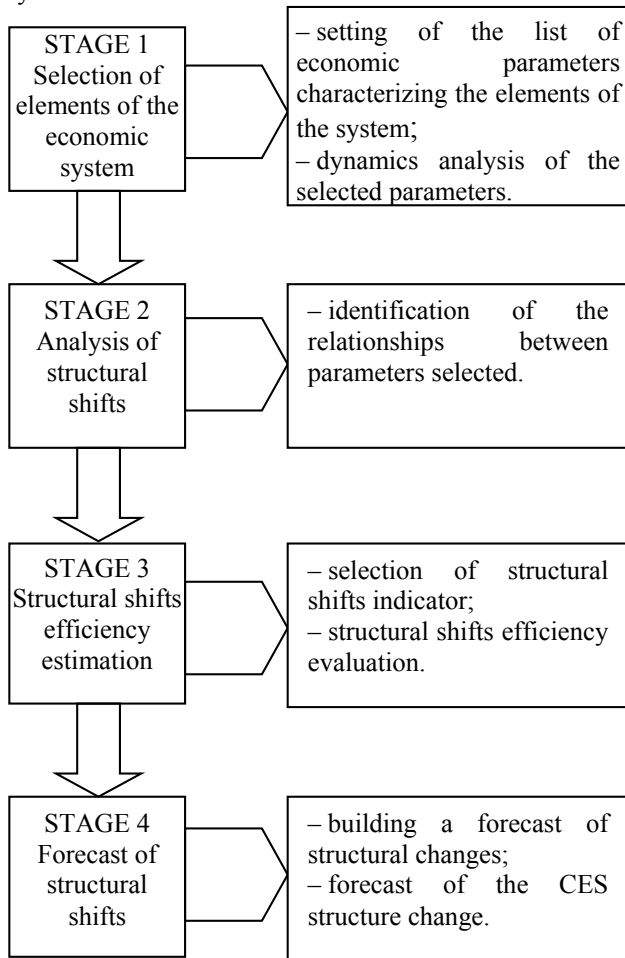economic indicators characterizing the elements of the system.

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┌─────────────────┐     ┌──────────────────────────┐
│ STAGE 1         │     │ – setting of the list of │
│ Selection of    │────▶│ economic parameters      │
│ elements of the │     │ characterizing the       │
│ economic        │     │ elements of the system;  │
│ system          │     │ – dynamics analysis of   │
│                 │     │ the selected parameters. │
└─────────────────┘     └──────────────────────────┘
        │
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┌─────────────────┐     ┌──────────────────────────┐
│ STAGE 2         │     │ – identification of the  │
│ Analysis of     │────▶│ relationships between    │
│ structural      │     │ parameters selected.     │
│ shifts          │     │                          │
└─────────────────┘     └──────────────────────────┘
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┌─────────────────┐     ┌──────────────────────────┐
│ STAGE 3         │     │ – selection of           │
│ Structural      │     │ structural shifts        │
│ shifts          │────▶│ indicator;               │
│ efficiency      │     │ – structural shifts      │
│ estimation      │     │ efficiency evaluation.   │
└─────────────────┘     └──────────────────────────┘
        │
        ▼
┌─────────────────┐     ┌──────────────────────────┐
│ STAGE 4         │     │ – building a forecast of │
│ Forecast of     │────▶│ structural changes;      │
│ structural      │     │ – forecast of the CES    │
│ shifts          │     │ structure change.        │
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**Fig. 2.** Stages of the CES structural shifts analysis.

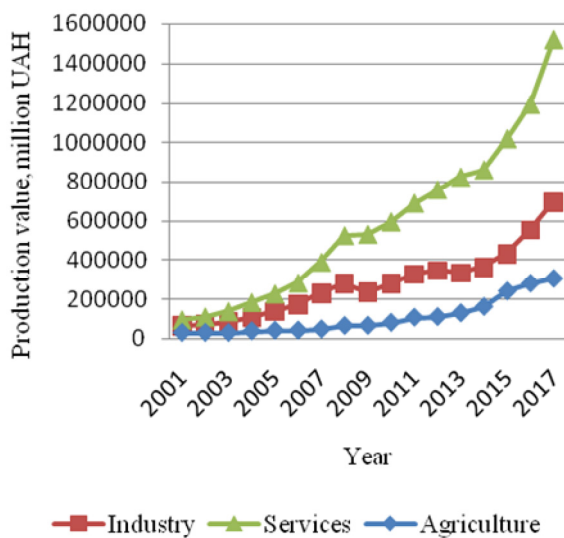Dynamics of the GDP change in actual prices is presented in Fig. 3.

**Fig. 3.** Ukrainian GDP dynamics by type of economic activity in actual prices between 2001 and 2017 [2].

Thus, the dynamics of GDP change in the actual prices by sectors of economic activity is described by an exponential dependence on time and is as follows:
– agriculture:

$$Y(agrc)_t = 18921e^{0,156t} \qquad (1)$$

– industry:

$$Y(ind)_t = 65267e^{0,137t} \qquad (2)$$

– services:

$$Y(s)_t = 96866e^{0,166t} \qquad (3)$$

The analysis of the model parameters (1)-(3) confirms that rate of the GDP change is different for each sector: the services sector shows the highest growth rate, which proves its accelerated development. The agriculture sector demonstrates the lowest rate, which stands for rigidities.

The dynamics of employment rate change within sectors of economic activity is represented in Fig.4.
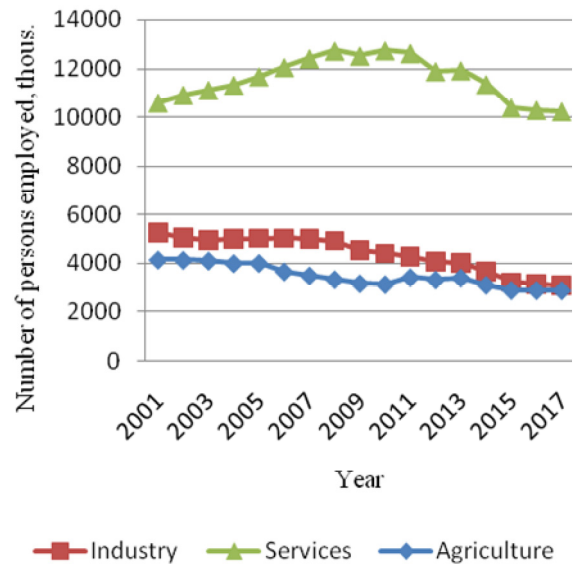
**Fig. 4.** Dynamics of employment by sectors in Ukraine between 2001–2007 [11].

Thus, the dynamics of changes in the number of employed persons by the sectors of economic activities is described by a parabolic dependence on time and is as follows:
– agriculture:

$$N(agrc)_t = -38,04t^2 + 658,7t + 9632 \qquad (4)$$

– industry:

$$N(ind)_t = -9,24t^2 + 27,17t + 5112 \qquad (5)$$

– services:

$$N(s)_t = 2,712t^2 - 134,5t + 4392 \qquad (6)$$

The number of persons employed by the sectors of economic activities in Ukraine tends to decline, which is

due to the decrease in the number of people in Ukraine during the period under study. However, the analysis of the models (4) - (6) extremum led to the conclusion that:
– in the agriculture sector for the model (4) $t_{min}$=24,8 which corresponds to the period between 2024 and 2025, that is, in the case of unchanged current trends before the specified period, there will be the reduction in employment, which will be followed by the growth;
– in the industry sector for the model (5) $t_{max}$=1,47, which corresponds to the period between 2001 and 2002, the growth was observed before the specified period, which was followed by the reduction in employment;
– in the services sector for the model (6) $t_{max}$=8,66, which corresponds to the period between 2008. and 2009, the growth was observed before the specified period, which was followed by the reduction in employment.

In the second stage of the analysis of the CES structural changes, the interrelations between the selected parameters are determined.

The linear regression models are built to analyze impact of the number of employed people on the GDP volume:
– agriculture:

$$Y(agrc)_t=647960,3-156,51N(agrc)_t \qquad (7)$$

$R^2$=0,65, $F_{calc}$=27,91.

– industry:

$$Y(ind)_t=122916-217,08N(ind)_t \qquad (8)$$

$R^2$=0,86, $F_{calc}$ =89,81.

– services:

$$Y(s)_t=2150274-135,44N(s)_t \qquad (9)$$

$R^2$=0,09, $F_{calc}$ =1,42.

The models (7), (8) are qualitative and statistically significant with a probability of 95%. The analysis of model parameters shows that the growth of the number of people employed in agriculture and industry leads to a reduction in production volumes, such a situation in these sectors is explained by the low production efficiency. In the services sector, this trend is not confirmed, since the model (9) is statistically insignificant

In the third stage, an indicator of structural shifts at the beginning and end of the analyzed period is estimated for the analysis of the efficiency of the structural shifts in the Ukrainian economy and the efficiency of the structural shifts is determined.

Thus, the authors use a "conditional sector productivity" parameter as an indicator of the shifts, which is determined by the ratio of the GDP share in the corresponding sector to the share of the population employed in this sector, that is:

$$YP(i)_t=dY(i)_t/dN(i)_t, \qquad (10)$$

where $YP(i)_t$ is a conditional productivity of *i*-sector of economic activity (*i*=1...*K*, *K* - number of sectors of economic activity) during period *t*, $dY(i)_t$ - the share of *i*-sector of economic activity in the country's GDP during period *t*, $dN(i)_t$ - the share of the employed population in the *i*-sector of economic activity during period *t*.

If:
– $YP(i)_t$<1, then labor force is used inefficiently in the *i*-sector of economic activity;
– $YP(i)_t$=1, then labor force is used with the unity efficiency in the *i*-sector of economic activity;
– $YP(i)_t$>1, then labor force is used efficiently in the *i*-sector of economic activity.

At each period of time *t* the following correlations will be performed:

$$\sum dY(i)_t=1 \qquad (11)$$

$$\sum dN(i)_t=1 \qquad (12)$$

The structural shifts shall be considered efficient if, in the structure of the economy during the analyzed period, the share of such a sector of economic activity increases, the conditional productivity of which grows at the most rapid rates.

The results of estimation of the conditional productivity parameter by sectors of economic activity in Ukraine are given in Table 1.

**Table 1.** Conditional productivity by sectors of economic activity in Ukraine.

| Sector of economic activity | 2001 |
|---|---|
| Agriculture | $YP(agrc)_{2001}$=0,16/0,21=0,76 |
| Industry | $YP(ind)_{2001}$=0,34/0,26=1,3 |
| Services | $YP(s)_{2001}$=0,5/0,53=0,94 |
| | 2017 |
| Agriculture | $YP(agrc)_{2017}$=0,12/0,18=0,65 |
| Industry | $YP(ind)_{2017}$=0,27/0,193=1,4 |
| Services | $YP(s)_{2017}$=0,6/0,63=0,95 |
| | Deviation |
| Agriculture | -0,11 |
| Industry | +0,10 |
| Services | +0,01 |

Analyzing the data given in Table 1 the authors have come to the conclusion that the share of the Ukrainian economy in agriculture and industry is decreasing both in the GDP and the total number of the employed people. However, if the conditional productivity in the industry sector has increased over time, it has decreased in the agriculture, which may indicate an ineffective use of the labor force, and if the current trends persist for an extended term, this type of activity may disappear.

As for the services sector, we can assume that the effective structural changes are taking place in this field of activity, but the conditional productivity has not reached unity.

In general, the structural shifts efficiency estimation shows that they are not effective in the Ukrainian economy, as the share of the services sector is

increasing, while the productivity is growing more rapidly in the industry.

After the structural shifts efficiency estimation, we proceed to the fourth stage of the analysis, i.e. a structural changes forecast.

The forecast of the CES structural changes is carried out in several steps:
– building the forecast for certain structural economic parameters of the CES development, i.e. $dY(i)$, and $dN(i)$;
– building the forecast of the CES structure change.

Any socio-economic parameter has both structural and dynamic characteristics. When forecasting and putting them into the link equation, there is a violation of equality, that is, error forecasts. Since when forecasting the structural parapeters of the CES development, there is a violation of the relationship equations (11)-(12), it is advisable to use a forecasting method based on related socio-economic parameters. The essence of this method is that the deviation of the forecast is distributed between the components. Due to this distribution, the forecast of the resulting parameter is corrected.

So, the forecast of the shares in the country's GDP by economic activity has been carried out.

The dynamics of the agriculture share in the country's GDP is presented in Fig. 5.
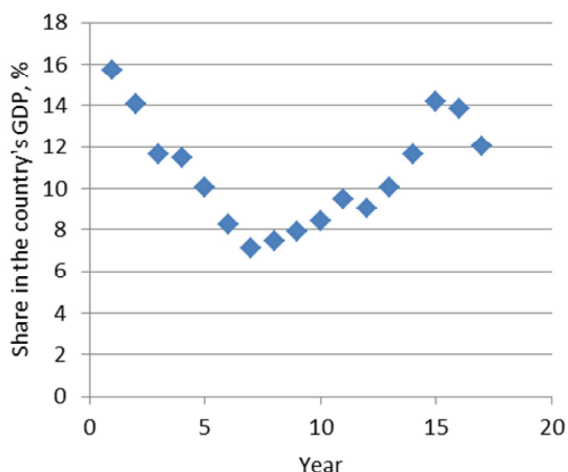


**Fig. 5.** The dynamics of the agriculture share in the country's GDP.

The analysis of the dynamics of the agriculture share in the country's GDP suggests that during the period of the study the trend changed twice, so, the forecast is carried out on the basis of a linear trend model, built on the last three parameters. The following model is obtained:
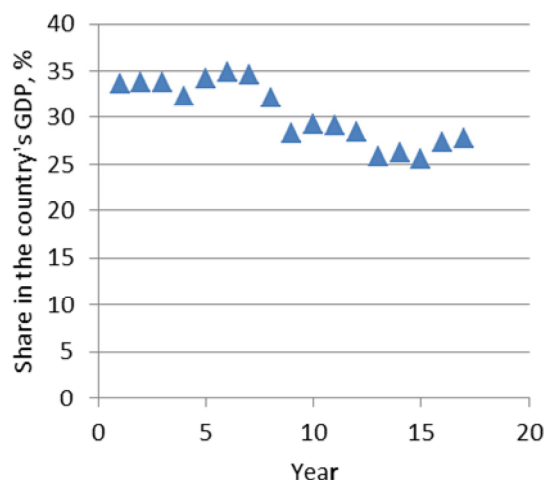
$$d(Y_{agrc}(t))=30,41-1,07t \qquad (13)$$

The forecast for the agriculture share in the country's GDP for the next year is 11,23%.

The dynamics of the industry share in the country's GDP is presented in Fig. 6.

The analysis of the dynamics of the industry share in the country's GDP indicates a decrease in the share. The trend of this change is described by a linear dependence:
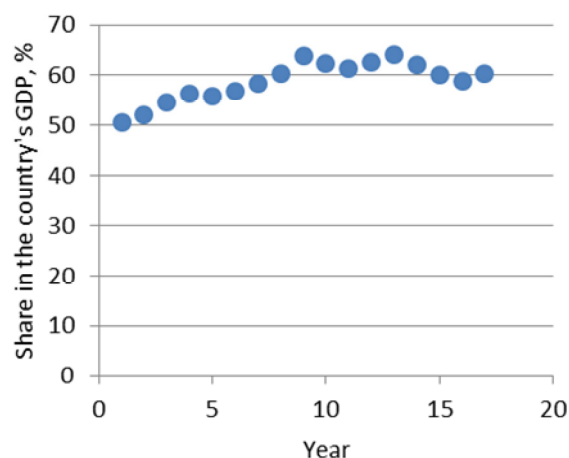
$$d(Y_{ind}(t))=35,67-0,59t \qquad (14)$$



**Fig. 6**. The dynamics of the industry share in the country's GDP.

The forecast value of the share of industry in the country's GDP for the next year is 25,14%.

The dynamics of the services share in the country's GDP is presented in Fig. 7.



**Fig. 7.** The dynamics of the services share in the country's GDP.

The services sector share in the country's GDP increases yearly. The trend of this change is described by the linear model:

$$d(Y_s(t))=53,45+0,6t \qquad (15)$$

The forecast value of the services share sector in the country's GDP is 64,29%.

The sum of the forecast values of the shares of the sectors of economic activity is 100,65%, thus the forecast error is 0,65%. The discrepancy is distributed, taking into account the coefficient of determination (quality coefficient) of the linear models (13) - (15).

Taking into account such considerations: the most prognostic value is corrected for the sphere of economic activity, which has a trend model with the least determination coefficient.

After the distribution of the discrepancy, the following prediction values are obtained:
– the agriculture – 11,05 %;
– the industry – 24,98 %;
– the services – 63,97 %.

The essence of this method is that a forecast deviation is distributed and corrected the forecast of the resulting indicator, as well as the functions of its structural indicator.

# 4 Conclusions resulting from the study

The analysis of the trends in the development of the Ukrainian economy has led to the conclusion that there is a redistribution of the share of production and the share of people employed between the sectors of economic activity.

This work proposes a stagewise procedure for analyzing trends in the development of the country's economy, taking into account the structural changes. The indicator of structural shifts is proposed and the effectiveness of structural changes in the economy of Ukraine is determined. The structural shifts in the economy of Ukraine can not be considered effective, since the share of the services sector is growing, and the productivity in this field of activity has not even reached unity, but in the industry sector, the productivity is growing rapidly, and the share of this sector of economic activity is declining. Using the method of related socioeconomic indicators, the forecast of structural shifts in the Ukrainian economy for the next period is built.

The use of the proposed analysis procedure will improve the efficiency of the process of strategies elaboration of the country's economic development. The prospect of further research is to build a forecast of structural changes in the economy of Ukraine.

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