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DIGITAL TECHNOLOGIES IN INNOVATIVE AND STRUCTURAL TRANSFORMATION OF UKRAINE'S ECONOMY

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ABSTRACT

The article substantiates the role of artificial intelligence in procuring the management of innovation and structural transformation of the economy. The analysis of structural shifts in gross value added in the economy of Ukraine during 2002–2019 is carried out. Solow's residuals are calculated for the primary, secondary and tertiary sectors. The expediency of managing the innovative and structural transformation of Ukraine's economy on the basis of changes in the level of Solow's residual in that sector and in the period of time determined by big data analysis by artificial intelligence is proved. A VAR model was built in the EViews environment for Solow's residuals in three sectors of the Ukrainian economy. Based on variance decomposition and IRF, it is established that increasing the share of intermediate consumption by the secondary sector of education, ICT, professional, scientific and technical services will increase Solow's residual in the secondary sector in two years, in the tertiary sector in three years and in the primary sector in four years, which will affect the increase in output in Ukraine during these three years.

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1. Introduction. In today's world, innovation is an integral part of economic growth, and innovative development is the basis for ensuring long-term prosperity. That is why the process of structuring the national economy must take into account the possibility of creating such conditions that would facilitate the transition to an innovative model of development.

The use of digital technologies in various socio-economic spheres not only promotes innovative development, but also serves as a mean of managing changes in the sectoral structure of the economy. In this aspect, the digital technologies is important tool for ensuring the innovative and structural transformation of the primary, secondary and tertiary sectors of the economy.

The research of digital technologies importance in the transformation processes of the Ukrainian economy is devoted to the research of the following scientists: Kraus N., Kraus K., Pigarev Y., Kosteniuk N., Putzenteilo P., Humeniuk O., Tulchynska S., Korzun L. and others. Despite the breadth of the concept of "digital technology", in this study attention is paid to the use of artificial intelligence in modeling changes in the sectoral structure of the economy to form an innovative model of development.

The first model to describe the role of technology in economic growth is the Solow-Swan model, which became the basis for modern theoretical and empirical work on economic growth. Modern models of economic growth focus on the study of economic growth factors, which mainly reflect the "development of educational and scientific and technical factors" (Grossman, 2017; Romer, 1986), such as: innovation and externalities, for example, in the model of Agion F. and Havitta P. (Aghion, 1992), Schultz T. (Schultz, 1961); accumulation of physical and human capital, for example, in the model of Guarini J. (Guarini, 2009) etc.

The aim of the study is to substantiate the theoretical provisions and provide practical recommendations for modeling structural and innovative transformations of the Ukrainian economy using artificial intelligence.

2. Materials and methods. The research used a set of general and specific methods at the empirical and theoretical levels to test hypotheses, such as: method of VAR analysis; impulse response functions (IRF); variance decomposition (VDC); method of graphic interpretation; methods of systematization, grouping and logical generalization for systematization of information, drawing conclusions and making scientific proposals of the research paper.

The study of the structural transformation of Ukraine's economy was conducted on the basis of Clark K. three-sector model (Clark, 1940), where the primary sector includes sectors A and B, the secondary sector – C, D, E and F, and the tertiary sector the rest economic activities (G–U) according to ISIC rev.4.

The calculation of structural changes in the economy by three sectors of the economy was carried out on the basis of the Kazynets method, which was supplemented by Romanova T. (Romanova, 2016).

$$K_K = \sqrt{\frac{(d_t^I - d_{t-1}^I)^2 + (d_t^{II} - d_{t-1}^{II})^2 + (d_t^{III} - d_{t-1}^{III})^2}{3}}; \quad (1)$$

K_K – the quadratic coefficient of "absolute" structural shifts of Kazynets, d_t^I – share of value added of the primary sector in the current year, d_t^{II} – share of value added of the secondary sector in the current year, d_t^{III} – share of value added of the tertiary sector in the current year, d_{t-1}^I, d_{t-1}^{II}, d_{t-1}^{III} – shares of sectors in the previous year.

Based on the Cobb-Douglas production function with a constant return to scale, the Solow's residuals were calculated for three sectors of the economy (Cobb, 1928).

$$\ln(A) = \ln(Y) - \beta \cdot \ln(L) - \alpha \cdot \ln(K); \quad (2)$$

$$A = e^{\ln(Y) - \beta \cdot \ln(L) - \alpha \cdot \ln(K)}; \quad (3)$$

Output (Y) is a function of capital (K) with elasticity α, labor (L) with elasticity β and knowledge (A). The function (3) suggests that output can be increased for any given amount of capital and labor by expanding the stock of knowledge.

The relationship between Solow's residuals in three sectors of Ukraine's economy is determined by building a VAR model using artificial intelligence. Based on the IRF and VDC, the sector of the economy in which the Solow's residual has the greatest impact on the residuals in other sectors was identified, as well as the impact of intermediate consumption by the target sector of innovation development driving services.

The study was conducted on the basis of data on value added, employment, capital in three sectors of the Ukrainian economy during 2002-2019, as well as intermediate consumption by the secondary sector of education, ICT, professional, scientific and technical services. The empirical basis of the study is the data of the State Statistics Service of Ukraine (SSSU, 2019), the International Labor Organization (ILO, 2019) and UNCTADstat (UNCTAD, 2019).

3. Results. Economic growth is a process that significantly depends on the specifics of the transformation in the structure of the economy. It should be noted that the dynamic characteristics are important in the analysis of changes in the national economy in terms of primary, secondary and tertiary sectors, because the current trends allow to identify potential deviations from the desired trajectory of development.

The macroeconomic indicator that plays a significant role in the study of the sectoral structure of the economy is gross value added. The analysis and assessment of the sectoral structure of the economy according to this indicator was conducted in the works of Peleh O. (Peleh, 2019), Herrendorf B., Rogerson R. and Valentini A. (Herrendorf, 2014), Trubnik T. (Trubnik, 2014), Karintseva O. (Karintseva, 2018), Maryanovych V. (Marjanović, 2015), Kołodziejczak V. (Kołodziejczak, 2020).

In 2019, the volume of gross value added in Ukraine increased 3.6 times compared to 2010, and in the sectoral context: the value added of the primary sector – 4 times, the secondary – 3.1 times, and the tertiary – 3.6 times. The primary and secondary sectors are quite close in terms of value added during 2010–2019, and the tertiary sector exceeds their sum by an average of 1.6 times (Fig. 1).

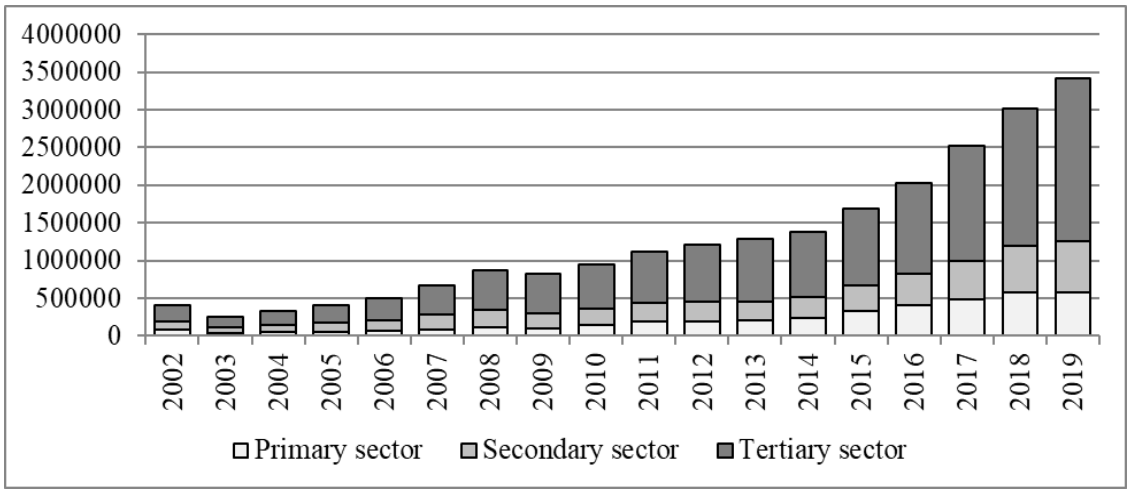

Fig. 1. Gross value added by sectors of the Ukraine's economy during 2002–2019, UAH million (SSSU, 2019; UNCTAD, 2019)

During the period, the average annual growth for the entire economy was +177027 million UAH, of which: +29489 million UAH for the primary sector, +32677 million UAH for the secondary sector, +114861 million UAH for the tertiary sector. The average annual growth rate of the primary sector was 115.20%, the secondary sector – 112.34%, the tertiary sector – 116.09%, and in general – 114.83%. The sectoral structure of Ukraine's economy by value added differs markedly from the structure by GDP, as the tertiary sector of the economy accounts for a larger share of value added than GDP.

During 2002–2019, the share of value added of the primary sector ranged from 11.8–20.3% (-0.14% of average annual growth), the secondary sector – from 19.5% to 30.5 % (-0.55% of average annual growth), the tertiary sector – from 51.5% to 64.1% (+0.69% of average annual growth). It is worth noting that the share of the primary sector in GVA increased by 2016 (5.3% more than in 2010), and by 2019 had a declining trend (in 2019 it decreased by 3.4% compared to 2016). The share of the secondary sector of the economy in GVA tended to decrease throughout the study period, and in 2019 was 2.9% less than in 2010. The share of the tertiary sector in GVA had an inversely proportional trend to the primary sector (decrease until 2016 by 3.4% compared to 2010 and growth till 2019 by 4.5% compared to 2016).

The results of calculations of quadratic coefficients of «absolute» structural shifts indicate that the transformations of the Ukrainian economy according to this indicator during 2002–2018 were insignificant (did not exceed 1.8%). In 2019, the ratio reached 2.1%, which was due to a decrease in the share of GVA in the primary sector (-2.1%) and the secondary sector (-0.6%), as well as an increase in the share of value added in the tertiary sector economy (+2.8%). In primary production the share decreased both in agriculture, forestry and fisheries (-1.54%) and in extractive industry (-0.6%), in secondary production only in processing industry (-1.06%) and supply electricity, gas, steam and air conditioning (-0.06%). The main sections of ISIC rev.4, which ensured the growth of value added of the tertiary sector in 2019, were the following: information and telecommunications (+0.74%), public administration and defense, compulsory social insurance (+0.74%), professional, scientific and technical activities (+0.38%), real estate transactions (+0.23%), health care and social assistance (+23%), transport, warehousing, postal and courier activities (+0.21%), activities in the field of administrative and support services (+0.21%), temporary accommodation and catering, provision of other types of services (+0.17%), financial and insurance activities (+0.11%).

An assessment of the residual growth indicators of the three sectors of the Ukrainian economy during 2002–2019 was made (Table 1). The calculations give grounds to claim the instability of the formation of Solow's residual (A) within the specified period. Thus, in the primary sector of the economy, the Solow's residual had the lowest level in 2011 (close to zero) and the highest – in 2019 (191813.3023), but the figure exceeded one only in 2012, 2017 and 2019. A similar situation was observed in the tertiary sector, but growth peaks occurred in 2012 and 2016. In the secondary sector, the figure exceeded one in 2011–2013 and 2015–2017, significantly outpacing the rest of the sectors.

Table 1. Solow's residuals by sectors of the Ukrainian economy, 2002–2019

	Primary sector	Secondary sector	Tertiary sector
2002	1,72923E+13	6,90544E-10	6,03919E-20
2003	3,7278E-208	4,82316E+98	1,04276E+74
2004	4,8177E-21	1,78241E-15	2,52677E-46
2005	3,90733E-07	4,19423E-20	1,91138E-14
2006	0,01726532	1,16045E-20	6,97219E-23
2007	2,87263E-07	9,81763E-19	1,44055E-33
2008	1006,903288	8,2603E+119	1,46366E-75
2009	365387315,5	7163122,069	663462,0016
2010	1,50618E-06	1,3418E-06	0,057647247
2011	6,82909E-21	6,50829E+27	7,5708E-134
2012	190885,4326	3,20623E+18	4,67893E+28
2013	3,16379E-09	31759130492	0,047327008
2014	0,922109244	0,041478273	140,5518028
2015	8,0446E-10	4,77672E+58	0,00015026
2016	1,03265E-13	3,15433E+13	1,34073E+16
2017	35,6024382	4,30833E+24	3,01852E-36
2018	3,55247E-08	1,32771E-08	3,22783E-23
2019	191813,3023	2,24988E-08	0

**calculated on the basis of sources (SSSU; ILO; UNCTAD)*

Thus, there is a need to determine the distribution of value added between the primary, secondary and tertiary sectors of the economy, which would contribute to the formation of an innovative model of development. Of course, market regulation mechanisms will be aimed at maximizing GVA, i.e. the target function of market optimization of the division of labor and capital between the three sectors will take the form of (4).

$$Y = Y^I + Y^{II} + Y^{III} \to max; \quad (4)$$

Y^I – value added in the primary sector; Y^{II} – value added in the secondary sector; Y^{III} – value added in the tertiary sector.

In this case, the market mechanism of distribution of L and K will be based on the Cobb-Douglas functions for the primary, secondary and tertiary sectors of the economy (5).

$$\begin{cases} \ln(Y^I) = \ln(A^I) + \beta^I \cdot \ln(L^I) + \alpha^I \cdot \ln(K^I) \\ \ln(Y^{II}) = \ln(A^{II}) + \beta^{II} \cdot \ln(L^{II}) + \alpha^{II} \cdot \ln(K^{II}) \\ \ln(Y^{III}) = \ln(A^{III}) + \beta^{III} \cdot \ln(L^{III}) + \alpha^{III} \cdot \ln(K^{III}) \end{cases}; \quad (5)$$

L^I, L^{II}, L^{III} – employment in the primary, secondary and tertiary sectors of the economy; K^I, K^{II} and K^{III} – the value of fixed assets in the primary, secondary and tertiary sectors of the economy.

Given that at a certain point in time a certain amount of capital and human resources is available within the economy, the target function will have limitations (6).

$$\begin{cases} L^I + L^{II} + L^{III} \le L \\ K^I + K^{II} + K^{III} \le K \end{cases}; \quad (6)$$

L – total employment; K – total fixed assets.

We convert Y^I, Y^{II} and Y^{III} in the objective function (4) into a logarithmic form. Given the fact that the exponent of the natural logarithm of the indicator is equal to the value of the indicator, the objective function will look like this (7).

$$Y = e^{\ln(Y^I)} + e^{\ln(Y^{II})} + e^{\ln(Y^{III})} \to max; \quad (7)$$

Therefore, equation (7) with limitations (5) and (6) provides an algorithm for the distribution of factors K and L, as well as value added between the primary, secondary and tertiary sectors based on the action of market mechanisms. However, the effect of market mechanisms must be adjusted by government mechanisms to ensure long-term economic growth.

We see the feasibility of managing such parameters that ensure the formation of an innovative model of development. There is a choice between α, β and A. Although these parameters are determined by constants, they tend to change constantly, which is the property of the post-industrial

dynamic era. Even Hall R. in 1989 noted the inexpediency of perceiving Solow's residual as a constant, because it covers price fluctuations (Hall, 1989).

On the one hand, it would be appropriate to take into account the dynamic relationship between the three parameters for the three sectors of the economy. Such a simulation would result in a system of nine equations with a definite time lag. On the other hand, building a model with so many parameters requires historical data over a fairly long period of time (over 30 years). Thus, to construct a VAR-model for three parameters with a time lag of two years requires empirical data for 18 periods (years or quarters). In view of the above, it is advisable to ensure the availability of the dynamic analysis procedure, i.e. to reduce the number of input parameters for analysis based on time series.

Solow's residual, despite all the controversy of scientists, contains an innovative component, so we consider it appropriate to take it into account in the process of modeling changes in the sectoral structure. The formation of the indicator, in our opinion, depends not only on its own output, but also on the consumption of goods and services of other sectors. Many scholars agree that the primary sector of the economy is the starting point for sustainable economic growth, as it forms the basis of the supply chain for the secondary sector, as well as an intermediate consumption of tertiary sector services (Timmer, 2014). Solow's residual in the primary sector depends on the level of equipment of agriculture and mining, i.e. the amount of capital spent by the sector on manufactured goods. The greater residual of the primary sector means the greater the ability to develop new technologies. Therefore primary sector needs goods of secondary sector and services of the tertiary sector with higher consumer value. This is a stimulating factor for the modernization of production to create high value products, which forms the demand for high value services of the tertiary sector.

At the same time, changes in Solow's residual in one sector of the economy will provide a gradual change in the relevant indicators for other sectors, i.e. not simultaneously, but over a period of time. Based on the above, it is advisable to determine the relationship between the Solow's residuals in the primary, secondary and tertiary sectors of the economy of Ukraine based on vector autoregression model (VAR).

$$\begin{cases} A_t^I = -933{,}8639 \cdot A_{-1}^I - 0{,}169644 \cdot A_{-2}^I + 0{,}000434 \cdot A_{-3}^I \\ \quad +4{,}4 \cdot 10^{-122} \cdot A_{-1}^{II} + 4{,}1 \cdot 10^{-109} \cdot A_{-2}^{II} + 7{,}5 \cdot 10^{-113} \cdot A_{-3}^{II} \\ +3{,}81 \cdot 10^{-21} \cdot A_{-1}^{III} - 7{,}19 \cdot 10^{-65} \cdot A_{-2}^{III} - 3{,}11 \cdot 10^{-70} \cdot A_{-3}^{III} + 32413 \\ A_t^{II} = -4 \cdot 10^{117} \cdot A_{-1}^I - 7{,}3 \cdot 10^{113} \cdot A_{-2}^I - 3{,}8 \cdot 10^{110} \cdot A_{-3}^I \\ \quad +4{,}7105 \cdot A_{-1}^{II} + 1770393 \cdot A_{-2}^{II} + 321{,}8272 \cdot A_{-3}^{II} \\ +1{,}63 \cdot 10^{94} \cdot A_{-1}^{III} + 6{,}31 \cdot 10^{49} \cdot A_{-2}^{III} - 1{,}33 \cdot 10^{45} \cdot A_{-3}^{III} + 1{,}4 \cdot 10^{119} \\ A_t^{III} = 9{,}75 \cdot 10^{22} \cdot A_{-1}^I + 2{,}10 \cdot 10^{19} \cdot A_{-2}^I + 1{,}28 \cdot 10^{20} \cdot A_{-3}^I \\ \quad -1{,}14 \cdot 10^{-94} \cdot A_{-1}^{II} - 4{,}31 \cdot 10^{-89} \cdot A_{-2}^{II} - 9{,}27 \cdot 10^{93} \cdot A_{-3}^{II} \\ -0{,}3975 \cdot A_{-1}^{III} - 2{,}12 \cdot 10^{-41} \cdot A_{-2}^{III} + 3{,}84 \cdot 10^{-50} \cdot A_{-3}^{III} - 4 \cdot 10^{24} \end{cases}; \quad (8)$$

A_t^I, A_t^{II}, A_t^{III} – Solow residuals for primary, secondary and tertiary sectors.

The first and third equations in system (8) have 100% reliability, and the second – 10.88%.

Based on the variance decomposition, it was determined that currently the Solow residual in the secondary sector has the great impact on the formation of the A^I in the second period, on A^{II} and A^{III} in the first period, but for long run residual in primary sector has greatest impact on three sectors (Table 2).

Table 2. Variance decomposition of A^I, A^{II} and A^{III}

	Variance decomposition of A^I			Variance decomposition of A^{II}			Variance decomposition of A^{III}		
	A^I	A^{II}	A^{III}	A^I	A^{II}	A^{III}	A^I	A^{II}	A^{III}
1	100,0000	0,000000	0,000000	3,881849	96,11815	0,000000	3,899608	5,728188	90,37220
2	32,83540	67,16460	4,12E-06	99,99727	0,002706	2,47E-05	99,99725	0,002572	0,000181
3	99,99695	0,003026	2,47E-05	99,99738	0,002595	2,47E-05	99,99738	0,002595	2,47E-05
4	99,99738	0,002595	2,47E-05	99,99738	0,002595	2,47E-05	99,99738	0,002595	2,47E-05
5	99,99738	0,002595	2,47E-05	99,99738	0,002595	2,47E-05	99,99738	0,002595	2,47E-05
6	99,99738	0,002595	2,47E-05	99,99738	0,002595	2,47E-05	99,99738	0,002595	2,47E-05
7	99,99738	0,002595	2,47E-05	99,99738	0,002595	2,47E-05	99,99738	0,002595	2,47E-05
8	99,99738	0,002595	2,47E-05	99,99738	0,002595	2,47E-05	99,99738	0,002595	2,47E-05
9	99,99738	0,002595	2,47E-05	99,99738	0,002595	2,47E-05	99,99738	0,002595	2,47E-05
10	99,99738	0,002595	2,47E-05	99,99738	0,002595	2,47E-05	99,99738	0,002595	2,47E-05

Modeling of innovative and structural transformations of Ukraine's economy is aimed at accelerating economic growth, and thus increasing the Solow's residuals. Therefore, it is important that the impact of A is not only significant but also positive. To do this, the IRF technique was used for the given variables (Table 3).

Table 3. Response of A^{I}, A^{II} and A^{III} to innovations in A^{II}

	Response of A^{I}			Response of A^{II}			Response of A^{II}		
	A^{I}	A^{II}	A^{III}	A^{I}	A^{III}	A^{II}	A^{I}	A^{II}	A^{III}
1	78162,18	0,000000	0,000000	-6,6E+118	3,3E+119	0,000000	1,98E+24	2,40E+24	9,53E+24
2	-1,02E+08	1,46E+08	36282,99	-3,1E+122	1,6E+120	1,6E+119	7,62E+27	-3,86E+25	-3,79E+24
3	-7,06E+10	3,60E+08	35057389	2,9E+125	-1,5E+123	-1,4E+122	-7,09E+30	3,61E+28	3,52E+27
4	6,56E+13	-3,34E+11	-3,26E+10	-2,7E+128	1,4E+126	1,3E+125	6,59E+33	-3,36E+31	-3,27E+30
5	-6,10E+16	3,11E+14	3,03E+13	2,5E+131	-1,3E+129	-1,2E+128	-6,12E+36	3,12E+34	3,04E+33
6	5,67E+19	-2,89E+17	-2,82E+16	-2,3E+134	1,2E+132	1,2E+131	5,69E+39	-2,90E+37	-2,83E+36
7	-5,27E+22	2,68E+20	2,62E+19	2,2E+137	-1,1E+135	-1,1E+134	-5,29E+42	2,70E+40	2,63E+39
8	4,90E+25	-2,50E+23	-2,43E+22	-2,0E+140	1,0E+138	1,0E+137	4,92E+45	-2,51E+43	-2,44E+42
9	-4,55E+28	2,32E+26	2,26E+25	1,9E+143	-9,6E+140	-9,3E+139	-4,57E+48	2,33E+46	2,27E+45
10	4,23E+31	-2,16E+29	-2,10E+28	-1,7E+146	8,9E+143	8,7E+142	4,25E+51	-2,17E+49	-2,11E+48

Calculations based on artificial intelligence show that innovations in the A^{II} in secondary sector have a positive effect on the formation of A^{I} in the first three periods, A^{II} in the first two periods and A^{III} in the first period. That is why government intervention should now focus on adjusting the process of forming Solow's residual in secondary sector.

Given that Solow's residual contains an innovative component, its increase involves the use of drivers of innovative development, which launch and intensify the processes of knowledge accumulation, innovation and their commercialization. We believe that this process involves increasing the intermediate consumption of services of sections of the economy that produce driving services for innovative development: education (P in ISIC rev.4), ICT (J in ISIC rev.4) and professional, scientific and technical activities (M and ISIC rev.4). Thus, in order to increase Solow's residual in the secondary sector of the Ukrainian economy, it is necessary to increase the share of its expenditures on innovative development driving services. The dynamics of the secondary sector consumption share of the innovative development driving services is shown in Fig. 2.

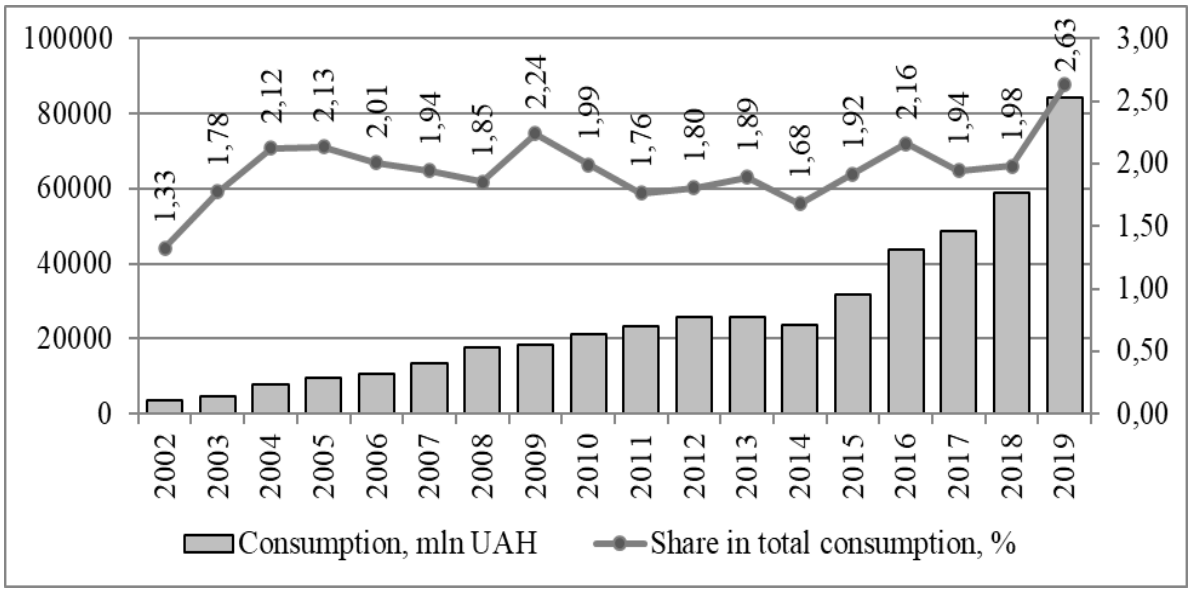

Fig. 2. Consumption of innovative development driving services by the secondary sector of Ukraine

Based on the data in Table 1 and Fig. 2 in the environment EViews it is established that the formation of A^{II} occurs on the basis of equality (9).

$$A_t^{II} = -2.8 \cdot 10^{120} - 0.307 \cdot A_{-1}^{II} - 0.196 \cdot A_{-2}^{II} - 0.369 \cdot A_{-3}^{II} - 0.196 \cdot A_{-4}^{II}; \\ +1.3 \cdot 10^{119} \cdot C_{-1}^{II} + 6.0 \cdot 10^{119} \cdot C_{-2}^{II} + 2.3 \cdot 10^{119} \cdot C_{-3}^{II} + 5.8 \cdot 10^{119} \quad (9)$$

C_t^{II} – secondary sector consumption share of the innovative development driving services in t period.

According to variance decomposition, consumption of education, ICT, professional, scientific and technical services by secondary sector has increasing the impact on A^{II} (from 0.779% in the second period to 25.63% in the 10th period). Similarly, IRF shows that innovations in C^{II} have a positive effect on the formation of A^{II} from the second period and have a long-term positive effect (Fig. 3).

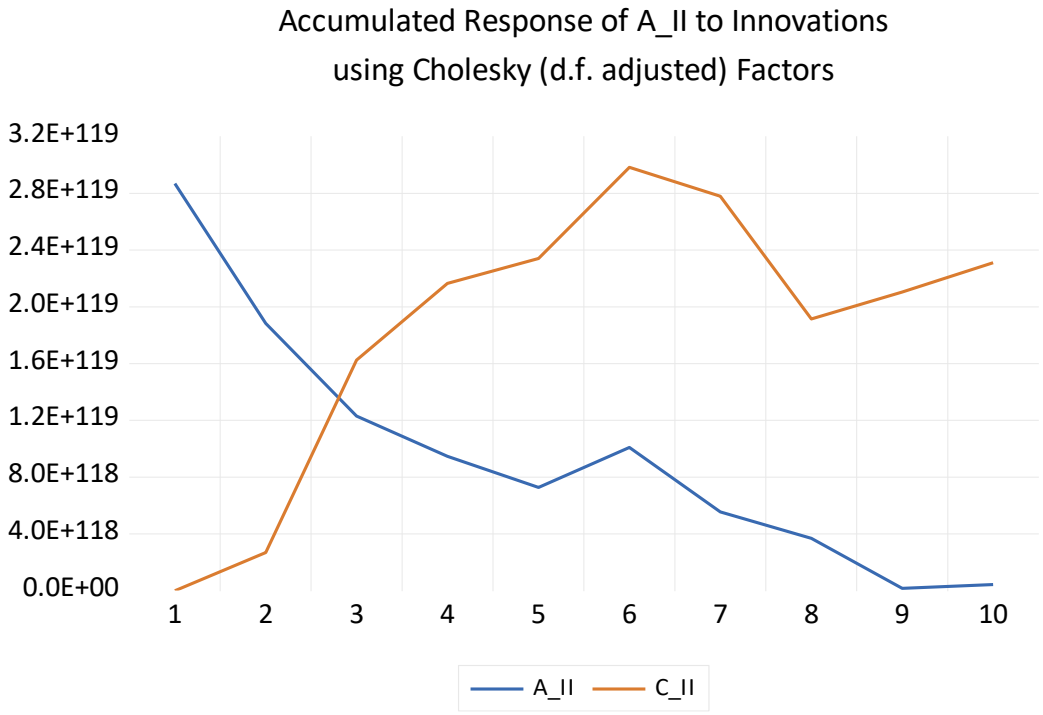

Fig. 3. Accumulated response of A^{II} to innovations of C^{II}

Therefore, the modeling of changes in the sectoral structure of the economy to form an innovative model of development should be based on the adjustment of market mechanisms for the distribution of resources between primary, secondary and tertiary sectors through the impact on the Solow's residuals. In view of the above, we propose a conceptual model of structuring the national economy, which covers actions for the successive periods (Fig. 4).

The zero period is represented by the processes of data collection, calculation of indicators, determination of the relationship and interaction between the Solow's residuals in the three sectors using artificial intelligence, identification of the target adjustment sector, determination of the relationship and interaction between the Solow's residual in the target sector and its consumption share of services related to education, ICT, professional, scientific and technical activities, selection of measures to increase the share of consumption of these services.

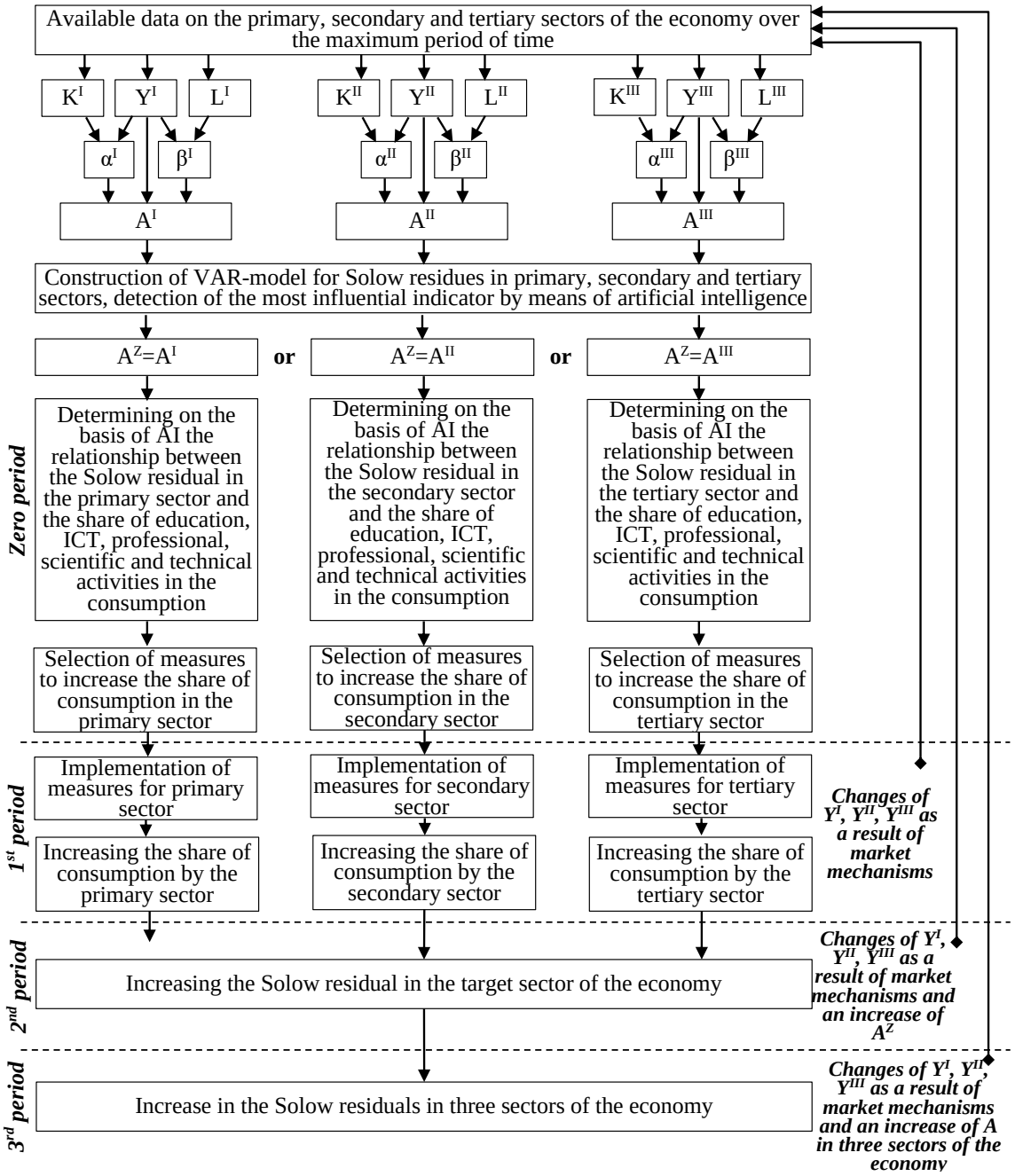

Fig. 4. Conceptual model of structuring the national economy

Within the first period, measures are being implemented to increase the consumption share of services related to education, ICT, professional, scientific and technical activities in the target sector of the economy. The effect of these measures in this period will be minimal and the structuring of the economy will be carried out mainly under the influence of market regulatory mechanisms. However, even minimal changes will provide additional data on the distribution of output, labor and capital, as well as changes in the residuals, which must be taken into account to adjust forecasts and measures.

In the second period, the Solow's residual in target sector will change as a result of an increase in the share of its consumption, which falls on education, ICT, professional, scientific and technical activities. This will lead to certain changes in the process of structuring the economy based on market mechanisms. As in the previous period, the model will have access to new data that must be included in the calculations to adjust current measures and / or select new measures.

With the onset of the third period, all three residuals will change, that will be marked by a significant increase in the influence of public administration on market mechanisms.

Of course, this conceptual model reflects the cyclical process of change, as well as its dynamism, because the choice of measures and their adjustment is based on data updates, which must be taken into account when using artificial intelligence.

The proposed model of structuring the national economy is aimed at forming an innovative model of development, and therefore, as a result of its practical implementation, the following changes are expected: (1) transition from extensive to sustainable development; (2) transformation of the value chain from low costumer value to medium and high; (3) changing priorities in favor of the interaction of innovative economic activities with all sectors of the economy. The implementation of this model is possible under the condition of constant use of artificial intelligence to regularly identification of key points, the change of which allows to transform the system of the national economy gradually with minimal state intervention in market regulation mechanisms.

4. Discussion. As a result of the study it was substantiated that the transformation processes in the economy occur under the influence of market mechanisms. Ensuring the vector of structural transformations for the formation of an innovative model of development requires government intervention in change, which must be justified by the analysis of big data using artificial intelligence.

A proposal has been made to implement changes in Ukraine's economy by interfering in the process of forming the Solow's residuals in three sectors of the economy by increasing the share of intermediate consumption of education, ICT, professional, scientific and technical services in the sector of the economy and the period of time, that determined in the EViews environment.

On the one hand, D. Liu, R. Li, and J. Tan note that the Solow's residual affects only 30% of output formation, but scientists draw conclusions based on a one-sector model (Liu, 2012). On the other hand, the study of T. Ten Raa and V. Shestalova confirms the fact that the indicator reflects technical and efficiency change, which in turn is a source of innovative and structural transformation of the economy (Ten Raa, 2011).

The consideration of intermediate consumption as a factor in the Solow's residual formation is indicated only by Z. Lin and T. Feng, but by substituting capital for it (Lin, 2016). Y. Bai, J.V. Rios-Rull and K. Storesletten argue that the formation of Solow's residual is influenced by demand (Bai, 2012), but the results of our study do not contradict this conclusion, but rather complement it, because increasing consumption of driving development services can optimize the production process and also increase the consumer value of products, which will positively affect the formation of demand.

5. Conclusions. As a result of studying the dynamic characteristics of the sectoral structure of Ukraine's economy during 2002–2019, it was found that the tertiary sector produces the largest and the primary sector the smallest share of value added. However, the largest sectoral contribution to the growth rate of value added falls on the primary sector.

It is noted that market mechanisms of economic regulation are aimed at maximizing output through the optimal distribution of factors of production between the primary, secondary and tertiary sectors. It is substantiated that making changes in the sectoral structure of the economy is to adjust market regulation mechanisms with the help of government levers. The process of market distribution, in addition to the elasticity of output of labor and capital in each sector, is influenced by Solow's residual, the management of which should be directed to public administration.

With the help of artificial intelligence, a conceptual model of structuring the national economy has been developed, which allows to identify key points of the system (sector of the economy that needs to increase Solow's residual) and specific changes that need to be made in a specific period (increasing by target sector consumption share of innovative development driving services), which is aimed at forming an innovative model of development. It is substantiated that the production of innovative development driving services falls on the following sections of ISIC rev.4: J, M and P. According to the proposed model, ensuring innovative development involves not just increasing investment in these economic activities, but increasing the share of intermediate consumption. The implementation of the model will achieve the following changes in the national economy: transition from extensive to sustainable development, transformation of low consumer value chains into medium and high value chains, change of priorities in favor of interaction of innovative economic activities with all sectors of the economy.

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