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Modeling of priority institutional measures to overcome threats to sustainable development of the region

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Abstract. The study suggests the methodology and model calculations of implementing priority institutional measures to overcome threats to sustainable development, the theoretical foundation of which is macroeconomic theory: aggregate demand, aggregate supply and the model of general macroeconomic equilibrium that allows modeling all the defined priority areas: 1) proposed measures to prevent corruption and reduce the level of shadowing of the economy by legislatively limiting markups for "padding firms" to no more than 15%, which limits the level of shadowing to no more than 15% and an increase in the share of wages in output at the level of EU countries – 0.28; 2) the quantitative impact of wage increases on macro indicators is shown; 3) adherence to realistic and optimistic development scenarios ensures innovation efficiency at the level of 0.89 and 2.1, respectively, instead of the current level of 0.13; 4) increase in investment, export of goods and services, household consumption and decrease in import of goods and services; an annual strategic plan for the restoration of the ecological component and its indicators on the trajectory of sustainable development has been developed, which ensures the level of reliability of environmental safety at the level of the EU countries.The simultaneous application of macroeconomic levers creates a cumulative effect of economic growth of all interconnected macroeconomic indicators.

1. Introduction

Sustainable development is an unconditional priority of global development and development strategies of civilized countries. However, the declared Sustainable Development Goals (SDGs) are extremely difficult to implement due to a range of circumstances where the main obstacle is the desire of corporations and oligarchs to enrich themselves. This jeopardizes not only sustainable development but also national security. Therefore, a very important task for scientists is to create such a methodology that would provide a clear and specific identification of threats to sustainable development in the security genesis dimension, would make it possible to accurately determine the priority areas of institutional measures for this purpose and offer specific institutional measures to

overcome threats to sustainable development with the possibility of quantification using impact modeling.

Numerous strong research papers [1-11] are dedicated to sustainable development issues, proving the fact that good governance and institutional efficiency are related to long-term development and sustainable success. Long-term progress in achieving SDGs can depend on improving institutional quality and reducing country risks to [1]; investigation of the relationship between long-term progress in achieving Sustainable Development Goals and improving institutional quality and reducing country risks [2]; modeling of organizational factors affecting the efficiency of implementing sustainability development at higher education institutions: the interpretive structural modeling (ISM) approach [3]; demonstrating how cause-effect diagrams can be used to find system leverage points [4]; justifying the multidimensional nature of sustainable development and proving that the science of sustainable development should play an important role in integrating different styles of evolution knowledge creation in order to fill the gap between science, education, practice and policy that is central to the successful advancement of the new paradigm [5]; justifying a comprehensive approach to sustainable development [6]; digitalization to achieve main Sustainable Development Goals: weighty steps towards a smart green planet [7]; the critical analysis of the impact of COVID-19 on the global economy, management and ecosystems and opportunities for cyclical economy strategies [8]; the relevance of cyclical economy practices for Sustainable Development Goals [9]; explaining the linkage of important success factors such as knowledge, skills, creativity and innovation with business model components [10].

So, particular publications explore different aspects of sustainable development. However, with the concept of sustainable development including so many various areas, scientists focus on addressing certain specific aspects that, despite their great importance, cannot offer a comprehensive solution to the problem. For example, it concerns issues of multidimensional description of the structure and system of indicators, formulation of sustainable development criterion, identification methodology, scientific justification of dynamic weighting coefficients, scientific justification of limits of the safe existence of active dynamic systems, methodology of sustainable development strategy in the security dimension, scientific justification of the definition of threats and problem components of sustainable development reflected in [11].

A separate task is the scientific justification of priority institutional measures to overcome threats and problematic components of today sustainable development in order to implement strategic scenarios by modeling macroeconomic levers of economic growth, which is the *purpose of the article*.

2. Material and Methods

The development of priority institutional measures to overcome threats is based on the study of substantiation of problematic active components of regional sustainable development in the genesis security dimension, which are determined by the deviation of components and indicators from the sustainable development criterion. This study resulted in the justification of four strategic areas of institutional measures that will allow covering almost all sustainable development indicators at the given regional level (10 components and 60 indicators), namely: 1) measures of de-shadowing and anti-corruption activities; 2) increasing the living standards and life quality of the our population; 3) stimulation of innovation, scientific and technological activities; 4) application of modern macroeconomic levers of state economic growth [11].

The theoretical foundation of institutional measures is the macroeconomic theory: aggregate demand, aggregate supply and the general macroeconomic equilibrium model. So, the methodology and model calculations of implementing priority institutional measures to overcome threats to sustainable development are based on the use of macroeconomic levers of state economic growth. To assess the impact of defined strategic areas on sustainable development indicators [11], we use impact multipliers calculated using the general macroeconomic equilibrium model including the aggregate condition demand function model, the aggregate supply function model and the general macroeconomic equilibrium model (Fig. 1.), which uses the ideas of J. Sachs [12].

The aggregate demand function model $Q^D(P)$ determines the dependence of nominal GDP on way changes in the general price level P – GDP deflator.

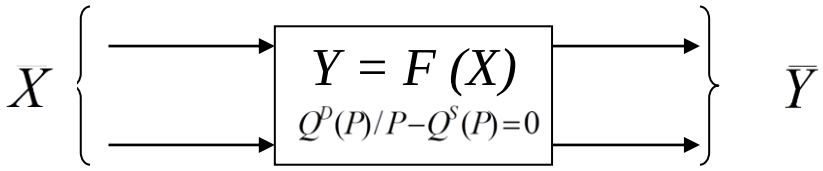

Fig. 1. A model of the country's (region's) economy as a complex functional system

The aggregate supply function model $Q^S(P)$ determines the dependence of real GDP on changes in the general price level P – GDP deflator.

The transcendental equation determining the interaction of existing aggregate demand $Q^D(P)$ and aggregate supply $Q^S(P)$ functions to achieve general macroeconomic equilibrium is the macrofunction of the economic system that defines total inflation *P* (GDP deflator).

$$Q^D(P_t)/P_t - Q^S(P_t) = 0 \quad (1)$$

Macrofunction *F* of the system as a quantitative expression of the main goal of the study depends on the controlling influence $\overline{X}$ (vector of input parameters) and at the same time ensures the achievement of influence on the corresponding initial indicators $\overline{Y}$ (vector of output parameters) – *transfer function of the system.*

This approach provides a scientific foundation for the implementation of institutional measures to overcome threats to sustainable development.

The analysis of existing models for forecasting the macroeconomic policy of economic growth [13-24] has revealed that most of them do not have a systematic approach – the interaction of aggregate known demand and aggregate notable supply functions for endogenous determination of the integral indicator of inflation in the country's economy – GDP deflator, real GDP and its growth rate. Approximation of macroeconomic relationships by linear regression equations makes it quite difficult to reproduce real economic dynamics in the context of transformational economy.

Besides, particular models feature shortcomings and simplistic approaches that are applied either as Say's statement *"Supply creates its own demand"* or Keynes' statement *"Demand creates its own supply"*, but most of them testify in favor of supply. Aggregate demand in neo-Keynesian approaches is considered in a very simplistic view under the assumption of a possible constant price standard and exogenously given rates of labor growth directly related to the rate of state economic growth.

Combining models $Q_t^D(P_t)$ and $Q_t^S(P_t)$ (i.e. the application of both Keynesian approach – *demand creates its own supply* and classical approach – *supply creates its own demand*) allows us to calculate an integral indicator of inflation in the country's economy – GDP deflator, real GDP and its growth rate, as well as to determine the actual impact of various supply and demand agents on them (Fig. 2).

The given model allows us to answer two main questions: how the initial macro indicators will change when fiscal and monetary policy tools are changed, and what controlled parameters should be to ensure the specified rates of economic growth. It is this model construction that allows calculating adequate multipliers of the main macro indicators to changes in the controlled parameters of supply and demand.

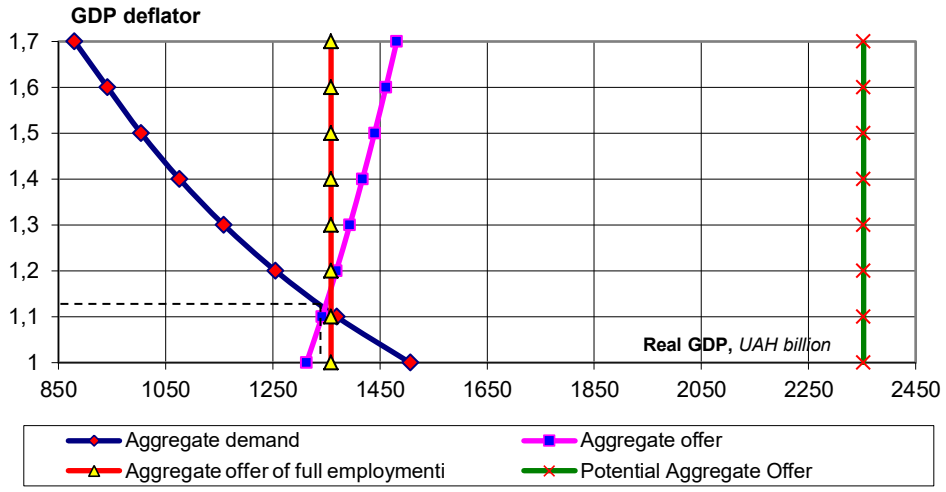

Fig. 2. A fragment of the overall macroeconomic balance of Ukraine in 2014.

3. Theory

The aggregate demand function model, which combines the goods, works and services market model with money monetary market and foreign exchange market models, is built on the principle of *IS–LM*-models suggested by Hicks-Hansen [25-26] and further developed by Mundell-Fleming [27-28] for open economy conditions. The Keynesian consumption function modified by M. Friedman [29] is used as a consumption function based on the concept of permanent income introduced by him.

Unlike the classical school of economics, the money market model does not use the orthodox quantitative theory of money, which takes into account only the transactional motive and the prudence motive, but uses the Baumol-Tobin money demand model [30-31] (transactional motive and prudence motive) simultaneously with the model of demand for money as property (Keynes' theory of liquidity advantage), changing depending on changes in interest rates. The Baumol-Tobin money demand model is used in a modified form adapted by V. Yushchenko and V. Lysitskyi [32] to the Ukrainian economy.

The difference of the developed model of the aggregate operation demand function $Q^D(P_t)$ is the calculation not of the scalar value of aggregate demand but its function from the change in the general existing price level – GDP deflator, the original combination of existing economic theories and the selected modeling apparatus for components of aggregate demand (2) in order to combine them into a single whole with the coordinated functioning of all elements and components (3).

$$\begin{cases} Q_t^D = F[C_t(Y_t^V, Y_{t-1}^V, T_t), G_t, E_t(e_t), Z_t(Q_t^D, e_t), I_t(i_t)] - \text{line } IS; \\ Q_t^D = F[M_t, P_t, i_t] \quad - \text{line } LM; \end{cases} \tag{2}$$

$$Q_t^D = Q_t^D(P_t) \quad - IS–LM \text{ model}, \tag{3}$$

where C_t is household consumption; Y_t^V is household disposable income; T_t is all taxes; G_t is consolidated state budget expenditures (allocated in the model to public social consumption C_g and public investment I_g); E_t is export of goods, works and services; e_t is UAH/USD exchange rate; Z_t is import of goods and services; I_t is investment; i_t is NBU refinancing rate; M_t is money supply (monetary aggregate M3); P_t is GDP deflator.

The aggregate supply function model is based on the famous neoclassical Cobb-Douglas production function with criterion constant returns to scale in the real form of J. Tinbergen [33]:

$$V_t^S(P_t) = e^{\gamma t}\left[N_{ef,t}(P_t)\frac{W_t}{P_t}k_{sn}\right]^{a_t}(\vartheta_t K_t)^{1-a_t-\beta}\left(\frac{G_{in,t}}{P_t}\right)^{\beta}; \quad (4)$$

where $V_t^S(P_t)$ is an actual output; $e^{\gamma t}$ is a technological progress; γ is the pace of the technological modern progress; L is labor costs ($L = N_{ef,t}(P_t)\frac{W_t}{P_t}k_{sn}$); $N_{ef,t} = \xi_t N_t$ is an efficient number of actual taxpayers (salaried employees, servants plus other category of employed persons reduced to the equal equivalent of salaried employees by all taxes, imposts and wages); ξ_t is the share of the number of actual taxpayers in total employment; N_t is total employment; W is average annual real nominal wages of salaried workers; k_{sn} is a social burden coefficient; ϑ is a capital utilization coefficient; K is capital expenditures; α is an elasticity coefficient at labor input; β is an elasticity coefficient for innovation expenditures; $1-\alpha-\beta$ is an elasticity coefficient for capital expenditures; G_{in}^{β} is nominal innovation expenditures; P_t is the GDP deflator; t is a time period.

The specification of the production function is determined by analytical methods research for each period separately based on actual current and retrospective data (for the previous period) and does not require long time series of variables. The aggregate supply function model allows calculating the volume of shadow economy.

The shift from origin to GDP (GRP) is happens via the production technology indicator (σ_t):

$$Q_t^S(P_t) = \sigma_t V_t^S(P_t) \quad (5)$$

Since separately neither $Q^D(P_t)$ nor $Q_t^S(P_t)$ determine the balance in the economy, as they are calculated at the given price standard, the general balance in the economy can be found only in the cooperation of all subjects of the economy on all aggregated markets, i.e. based on the interaction of these functions (1).

4. Calculation

According to the study [11], the methodology of security dimension of sustainable development components allowed us to define problematic components of the Kharkiv region by the criterion of deviation from the average value of the *homeostatic plateau* (6) (Table 1).

Table 1. Problematic factors and criterions of development of the Kharkiv region [11]

Factors	Criterions
Demographic	Economy-ecological
Innovative	Standard of quality living
Foreign economic	Informal
Investment and financial	Tour-recreation
Infrastructural	Structural

$$\Delta Y_{i,t} = 0.5\cdot(Y_{i,t}^{opt.Lower} + Y_{i,t}^{opt.Apper}) - Y_{i,t} \quad \to 0, \quad (6)$$

where $\Delta Y_{i,t}$ is deviation of the integral index from the point of the following sustainable development; $Y_{i,t}^{opt.Lower}$ is the lower optimal value of the vector of limit values; $Y_{i,t}^{opt.Apper}$ is the upper optimal value of the vector of important limit values; $Y_{i,t}$ is the current value of the weighty integral index.

To justify institutional measures, we will conduct modeling of overcoming threats to sustainable development by applying macroeconomic levers of regulatory economic growth and using multipliers of influence calculated using the general macroeconomic equilibrium model (Table. 2).

Table 2. Multipliers of the main macro indicators before changing the managed supply and demand parameters for Ukraine (calculations for peacetime)

Exogenous macro indicators	Endogenous macro indicators			
	Nominal GDP, *billion UAH*	Real GDP		Deflator GDP, *% point*
		% point	*Impact weight factor*	
Investments, *billion UAH*	2,82	0,14	0,0213	0,05
Revenues of the consolidated budget, *billion UAH* + –	 -2,28 1,58	 -0,041 0,028	 0,004267	 -0,119 0,081
Consolidated budget expenditures, *billion UAH* *for consumption* *on investment*	 2,58 2,57	 0,045 0,136	 0,02072	 0,134 0,037
Export of goods and services, *billion UAH*	3,54	0,095	0,01447	0,147
Import of goods and services, *billion UAH*	-5,73	-0,164	-0,02499	-0,236
Exchange rate, *UAH / USD* + –	 460,0 -520,0	 10,7 -12,0	 0,16305	 21,0 -24,3
Nominal salary, *UAH*	0,23	-0,0045	-0,005257	0,021
Coefficient of production technology, (*ratio of GDP to output*)	0,0	173,0	0,2621	-183,0
Capital loading ratio	0,0	192,0	0,2926	-202,0
The pace of scientific and modern technological progress, *%*	0,0	1,37	0,20877	-1,46
Labor demand, *million people*	39,0	2,82	0,04297	-0,3

4.1. Measures of de-shadowing and anti-corruption activities

The shadow economy in the state is a consequence and the main economic basis of authorities, corruption, on the one hand, and on the other hand, an inexhaustible reserve and some compensator of economic and financial risks. Calculations of shadow economy volumes are made using the aggregate supply function model (4,5).

The idea of the method of estimating shadow GDP is that there is some optimal correlation between elasticity coefficients of macro factors of the Cobb-Douglas production cooperation function – *labor and capital*, determining the allocation of income, obeying the regularity of a number of Fibonacci numbers (0.382 for labor inputs; 0.618 for capital inputs). We assume that deviation from this correlation determines the volume of shadow economy.

Calculations of the share of wages in the production output show that Ukraine and its regions lag significantly behind similar indicators in the EU (Fig. 3, *a*), while F. Schneider's calculations regarding shadowing of EU countries [35] show a decreasing dependence of the shadowing level at the increasing share of wages in the output (Fig. 3, *b*).

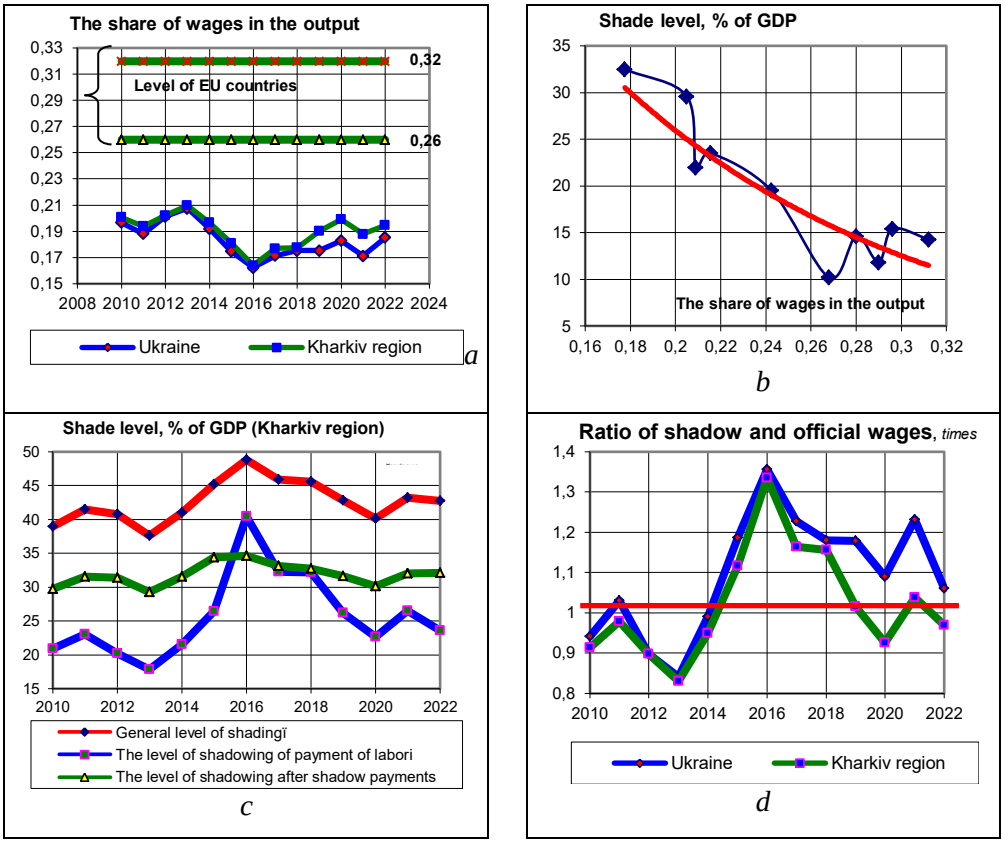

Fig. 3. Assessment of the main characteristics of shadowing of the economy

Consequently, the share of labor remuneration in the output is a clear indicator of the existence of shadow economy. The accounts show the following consistent dynamics of the overall level of shadowing in the Kharkiv region, the level of labor remuneration shadowing and the final level of shadowing after the payment of shadow wages in envelopes (Fig. 3, *c*).

In the economically developed EU countries, the share of labor remuneration in the output is in the range [0.26-0.32] (Fig. 3, *a*). The deviation from this correlation to a lesser extent is caused by the artificial increase in intermediate consumption through *shell companies* and the corresponding decrease in GDP. The consequence of this is the decrease in official wages and the excess of shadow wages over official ones, which reached almost 1.35 times in the Kharkiv region (Fig. 3, *b*).

Legislative prohibition to increase the price of the supplier of goods, works or services at the level of no more than, for example, 15% (a company that does not have any fixed assets for processing products and creating added value cannot increase the price by times) for *shell companies* can have the following effect (Table 3).

Thus, the difference between the actual and, after appropriate measures, the increase in intermediate consumption will determine an additional reserve of official GRP, which can be used for investment, social security, wage increases, etc. The consequence of this is the decrease in intermediate consumption and the increase in the coefficient of manufacture technology, i.e. the share of GRP in the production output.

It is impossible to accelerate the economic development of Ukraine and its regions without ensuring social security where, in the context of market relations, wages play a paramount role in the motivational mechanism.

Table 3. Assessment of the effect of restrictions on the markup of shell companies in the Kharkiv region.

Year	Actual GDP, billion *UAH*	GRP after events, billion *UAH*	Additional GRP, billion *UAH*
1	2	3	4=3-2
2010	65,29	74,95	9,66
2011	76,86	89,59	12,72
2012	82,22	95,72	13,50
2013	85,31	97,51	12,19
2014	96,59	112,58	15,98
2015	124,84	149,04	24,19
2016	154,87	185,25	30,38
2017	187,24	221,21	33,97
2018	233,28	274,67	41,39
2019	247,59	288,77	41,17
2020	257,81	296,82	39,01
2021	*314,88*	*368,67*	*53,79*
2022 (Rating)	*157,44*	*184,45*	*27,01*

The level of state social security both in Ukraine and in the Kharkiv region in particular is in a critical state exactly because of the humiliatingly low share of labor remuneration in the output (Fig. 3, *a*), which is [0.26-0.32] in the developed EU countries.

The main measures of de-shadowing of the labor market in Ukraine can be:

destruction of corruption in fiscal authorities; reduction and redistribution of tax overload; redistribution of income between employees and employers due to increased wages; strict punishment for non-compliance with the current legislation using high penalties for non-compliance with the current legislation, development of measures to increase tax integrity; reduction of population's income differentiation; introduction of tangible luxury taxes, progressive income taxation; increase in minimum state guarantees on labor remuneration; introduction of a close link between personal pension receipts to the Pension Fund and the amount of the pension.

4.2. Increasing the living standards and life quality of the national population

The most important indicators of social security (the level of wages in the output, expenditures on education and healthcare, the level of shadow wages, demographic burden, poverty rate, morbidity rate, etc.) primarily depend on wages that have a direct impact on aggregate demand (by increasing wages of the population → available household income → household consumption) and aggregate supply (by increasing the mass share of wages in the output → the number of salaried employees), which leads to the increase in GRP, GRP deflator and state economic growth rate in the long facts run.

Together with the nominal wage multiplier in Table 2 referring only to real GRP, it is necessary to find out the impact of nominal wages on final consumption of households (C) and, as a result, on nominal GRP, employment, GRP deflator and economic growth rates using statistical dependencies (Fig. 4).

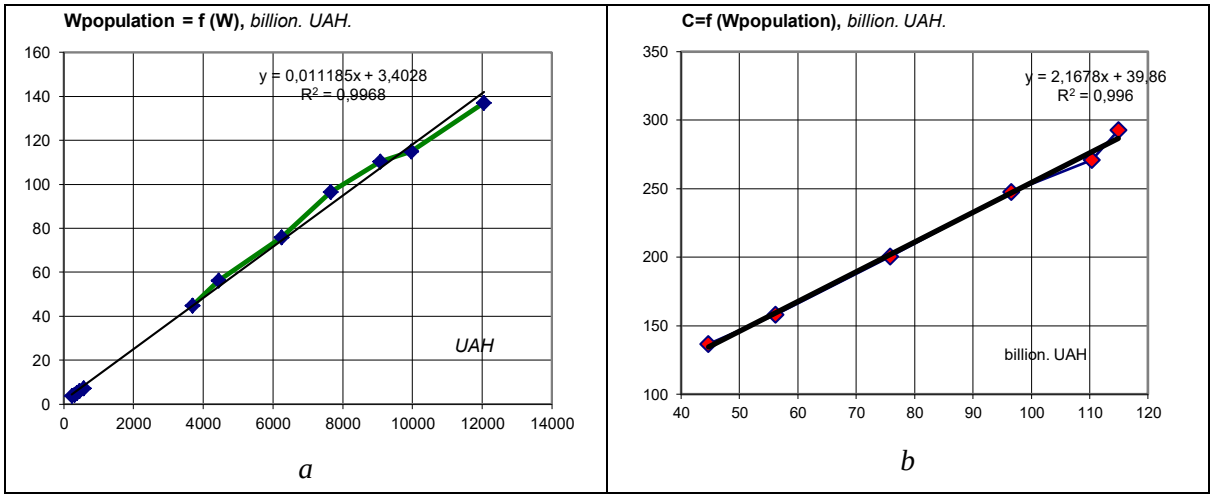

Fig. 4. Dependencies of population wages (*a*) and household final consumption (*b*) on average monthly wages in the Kharkiv region

Particular dependencies allow us to determine the corresponding multipliers, namely: the multiplier of wages to population wages – 0.011169; the multiplier of population wages to household final consumption – 1.848.

So, let's estimate the impact of increasing nominal wages in the Kharkiv region by 1,000 UAH in 2022 from 13,000 UAH to 14,000 UAH. It means that the increase in nominal wages by 1,000 UAH increases population wages by 11.169 billion UAH (1,000 x 0.011169), which increases household final consumption by 20.64 billion UAH (11.169 x 1.848).

Using multipliers from Table 1, we have:

- increase in nominal GRP by: (20.64 x 2.58) = 53.252 billion UAH;
- increase in the deflator by (20.64 x 0.134)=2.765%
- using the model of aggregate supply function (4.5), let's calculate the action of wage to maximixe on the optimal interest for labor.

The increase in nominal wages by 1,000 UAH initially leads to the decrease in demand for labor, but later the increase in consumption forces employers to increase the output of goods, works and services because of the grow in demand for labor and the increase in capital utilization. The resulting effect of the above-mentioned assumptions is the increase in the demand for labor by 0.0805 million people and the decrease in the GRP deflator by (0.0805 x 0.3) = 0.02415%. Thus, the final increase in the deflator will be: (1.25 + 0.02765 - 0.0002415) = 1.2774, with the following changes in macro indicators (Table 4).

Table 4. Changes in macro indicators due to the increase in nominal wages

Macro indicators	*W=13000 UAH*	*W=14000 UAH*
Nominal GRP, *UAH billion*	157,44	210,71
Real GRP, *UAH billion*	125,95	164,95
Growth rate of real GDP, %	-60,0	-47,6
GDP deflator	1,25	1,2774
The share of wages in the output	0,1947	0,1975

Adherence to the post-war strategic plan of restoring the sustainable development trajectory concerning the costs and life quality will significantly increase the efficiency of social investments.

4.3. Stimulation of innovation, scientific and technological activities

The idea of promising innovative growth of the national economy with all its obvious positive effect is not new and does not cause doubts. That is why the innovative economy is quite fairly declared as one of the priority areas of development, and its potential is realized at the national level. The success of innovation, scientific and technological activities largely depends on the sufficiency of resource support.

Innovative technologies are created by people who should be interested in creating state-of-the-art technologies, which is ensured by appropriate financing of their activities. Therefore, it is relevant to develop scientific approaches to determine the innovative contribution to economic growth (4) [34].

$$G_{in,t} = (G_{ndr,t} + G_{in.vit,t} + G_{osv,t}), \quad (7)$$

where $G_{in,t}$ is total innovation expenditures; $G_{ndr,t}$ is nominal gross domestic expenditures on R&D; $G_{in.vit,t}$ is nominal innovation expenditures; $G_{osv,t}$ is nominal total education expenditures.

Applying the Solow residual method [34] through logarithmization and logarithmic derivatives in the production function of equation (4), we can obtain formalized information labor, capital, scientific and technological progress, for example, innovation factors as in equation (8) [34].

$$Tempo\_Innov = \dot{\beta}(\ln G_{inn} - \ln P) + \beta\left(\frac{\dot{G}_{inn}}{G_{inn}} - \frac{\dot{P}}{P}\right), \quad (8)$$

where $\dot{\beta}$ is a derivative of the elasticity coefficient of innovation costs; $\dot{G}_{inn} / G_{inn}$, $\dot{P} / P$ are rates of the corresponding variables.

And innovation efficiency Ef_t can be defined as the correlation of the volume of sold innovations ($Q_{inn,t}$) to the joint expenditures on innovative factors ($G_{inn,t}$), as in equation (9):

$$Ef_t = Q_{inn,t} / G_{inn,t}. \quad (9)$$

Innovative factors of influence are the most promising and long-term, affecting the latest technological solutions and the shift to a higher technological mode. Therefore, assessing and developing appropriate measures of their efficiency is of paramount importance in the economic growth policy.

Calculations made by the Solow residual method of the production function (4,5) allow us to determine the average annual (for 22 years) contribution of production factors between 2001 and 2022 to the economic growth of the Kharkiv region (Table 5).

Table 5. Average annual values of the finishing touches of production indicators to the increase in GRP, *% facts growth per year*

Region	GRP	STP	Labor	Capital	Technological production	Innovative contribution
Kharkiv region	2,535	-3,148	3,565	1,217	0,508	**0,3937**

Between 2001 and 2022, the rate of innovative contribution to economic growth in the Kharkiv region varied from -1.396 to +1.716 %, leading to the decrease or increase in the returns to macro factors by 0.9861 and 1.0173 times (Fig. 5, *a*).

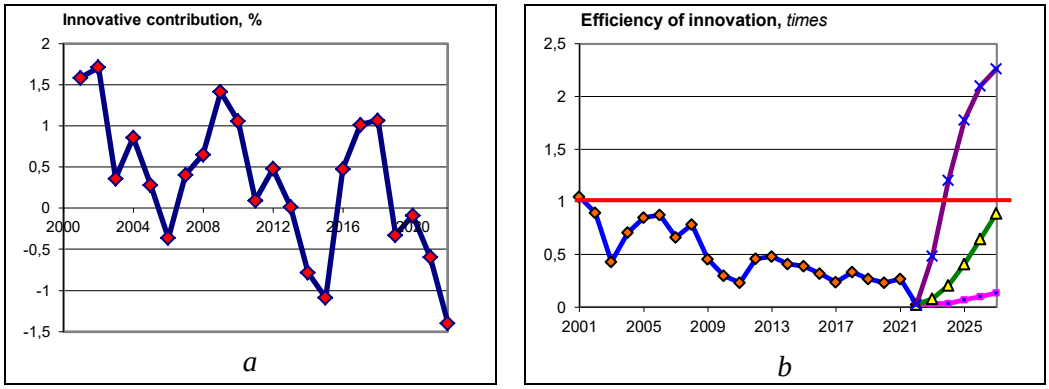

Fig. 5. Dynamics of innovative contribution to economic growth (*a*) and efficiency of innovations (*b*) in the Kharkiv region

Unfortunately, over the last 20 years, the efficiency of innovations has been less than one, the reproduction threshold of innovation investments (Fig. 5, *b*), which indicates the insufficiency of both total innovation expenditures and expenditures on scientific and technological activities. Adherence to the post-war strategic plan according to scenarios of restoring the sustainable development trajectory concerning innovation expenditures (R&D funding, innovation funding, education funding) will significantly improve the efficiency of innovation investments.

4.4. Application of regular macroeconomic levers of state economic growth

4.4.1. Level of real investment

Let's distinguish three channels of **investment** impact on economic growth:

- *increase in aggregate demand* [12, 38, 39], which causes the simultaneous growth of inflation (GDP deflator, GRP) and available household income, increasing savings and, as a consequence, investments, increasing productive capital or its utilization, increasing employment and aggregate supply, thereby reducing inflation;
- *accumulation of productive capital* [12, 38, 39]. As a rule, the cost of productive capital operating in period *t* is determined in the previous period (*t-1*), i.e. it depends on the capital of the previous period calculated given the integral indicator of inflation (GRP deflator);
- *maximization in the utilization of productive new capital in the current period* as a result of increased investment determines (real GDP, GRP) of the country or region and inflation (the angle of slope of this dependence determines to what extent the impact of investment will be distributed between economic growth and inflation) and non-linearly depends on the volume of attracted investment.

Consequently (Fig. 2) increasing real GDP and inflation (GDP deflator). On the contrary, the maximization in aggregate provision (due to the boost in investment and capital utilization real rate), which shifts the aggregate store curve also to the right, increasing real GDP and decreasing inflation. According to the conducted research (Table 2), the increase in the volume of investments (by three channels of impact), for example, by 1.0 billion UAH leads to the increase in GDP (GRP, GVA) by 2.82 billion UAH, which determines the height of state local budget revenues and, accordingly, the accretion of the spectrum of expenditures.

The Investment level indicator is the most critical in the Kharkiv region and decreased from 16% of output to 2% under the influence of the financial crisis of 2008-2009, the beginning of military aggression of the russian federation in 2014 and in 2022 (Fig. 6).

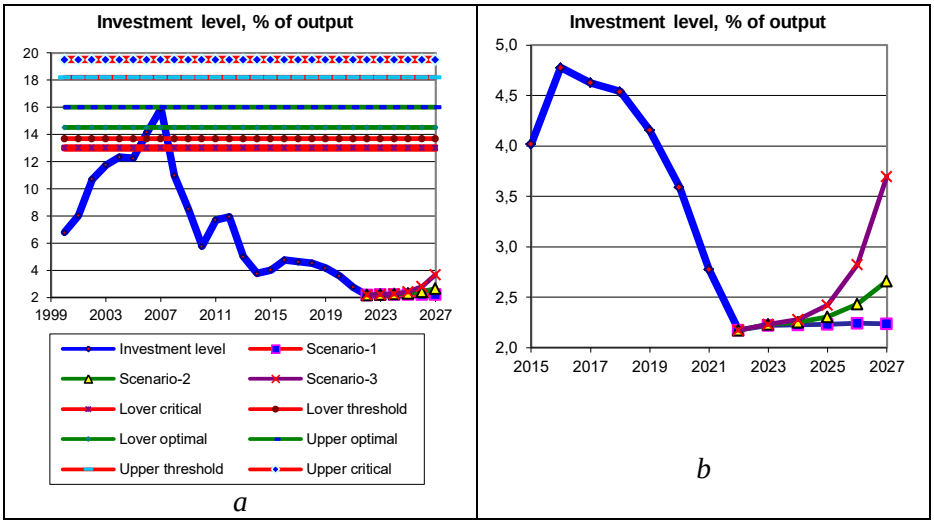

Fig. 6. Dynamics of the level of investment in the Kharkiv region

Even in the optimistic scenario of post-war development, it is only possible to increase it to 3.7% by 2027.

4.4.2. Import substitution and increase in export

According to the calculations (Table 2), the increase (decrease) in import of goods and services by 1 billion UAH reduces (increases) nominal GDP (GRP) by 5.73 billion UAH, real GDP growth – by 0.164 pp, GDP deflator – by 0.236 pp. The expand in import of goods, works and services is accompanied by displacement of the corresponding receptivity of domestic goods, works and services, which leads to the reduction in the income of producing enterprises, contributions to the budget and investments. Therefore, import substitution is an efficient measure to level the impact of import on economic state growth.

The enlarge in export of goods, works and services by 1 billion UAH increases nominal GDP (GRP) by 3.54 billion UAH, real GDP growth – by 0.095 pp, GDP deflator – by 0.147 pp. The multiply in export of goods, works and services is accompanied by the growth of incomes of exporting enterprises and, as a validity, by the augment in contributions to the purse and the increase in investments with known consequences.

4.4.3. Magnify in household using is similar to the enhance in budget expenditures that can be directed to consumption or investments. The directed to consumption by 1.0 billion UAH increases nominal GDP (GRP) by 2.58 billion UAH, real GDP growth – by 0.045 pp, GDP deflator – by 0.134 pp. Directed to investments, nominal GDP increases by 2.57 billion UAH, real GDP – by 0.136 pp, GDP deflator – by 0.037 pp. According to the calculations (Table 2), the multiplier of public expenditures dominates the multiplier of public revenues, so the real deficit of budget of up to 3% stimulates economic growth. Besides, if the lengthen in the consolidated budget expenditures is directed to increase investments rather than consumption, the growth rate of real GDP increases by 3 times due to the fact that the increase in inflation (GDP deflator) slows down by 3.6 times.

4.5. Strategic future variations of post-war reconstruction of the progress trajectory of the environmental component

There is no doubt about the importance of maintaining a balance between the three components of progress by maintaining economic state growth, promoting social development and striving for ecological sustainability. All previous measures have been directed precisely to the issue of economic

growth and social development, so it is important for the environmental component of regional sustainable development.

The deviation of indicator values from the sustainable development criteria (for each) shows development imbalances and the need for measures to improve them (Fig. 7, *a*).

The development of environmental component, we use the methodology of *scientific and strategic foresight* [12, 34].

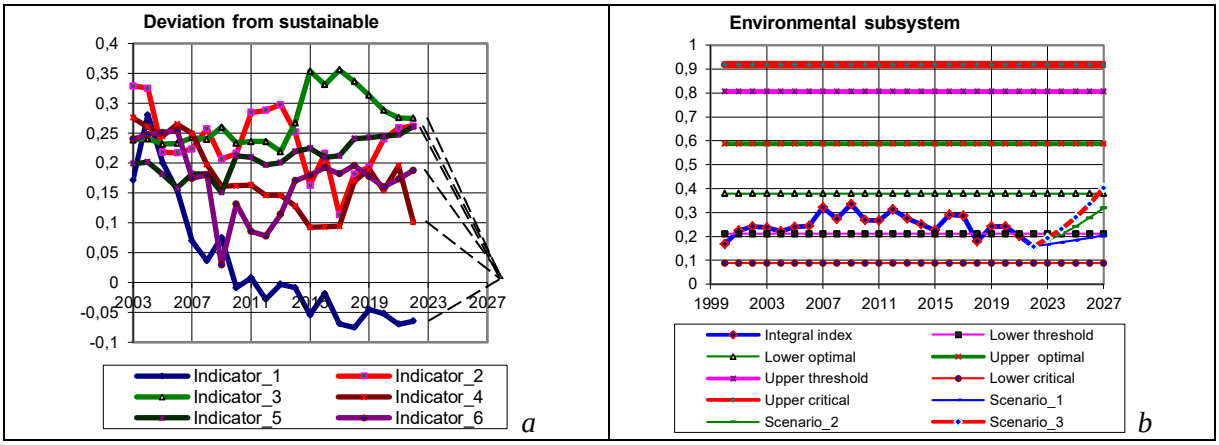

Fig. 7. Dynamics of threat indicators (*a*) and strategic development scenarios (*b*) of the Kharkiv region

Also, when developing variatiions for the future restoration of the trajectory of national development of the ecological component should be used factor-criterial assessment of the prerequisites of greening [41, 45], innovations attractiveness [42, 44], greening economy and manegement [43] and some other proposals of specialists proposed in the scientific literature [46-50].

Table 6. Assessment of strategic values of environmental safety indicators

Indicators / years	2022	2023	2024	2025	2026	2027
Environmental subsystem						
1) the level of pollutant emissions into the atmospheric our air per 1 km^2, ton (D);	0,0073	0,0068 0,0069 0,0068	0,0068 0,068 0,0067	0,0068 0,0067 0,0064	0,0068 0,0064 0,0057	0,0068 0,0059 0,0044
2) the level of use of fresh water per 1 person, m3 (D);	115,38	115,37 115,32 115,28	115,35 115,12 114,79	115,31 114,57 113,25	115,26 113,32 19,8	115,18 111,0 103,5
3) the level of the haunch of circulating used water per 1 resident, m3 (S);	461,5	462,1 464,2 466,0	463,1 472,2 485,4	464,5 494,2 544,1	466,6 541,4 660,7	469,9 621,9 843,5
4) the level of discharge of polluted return water into surface water bodies per 1 resident, m3 (D);	3,846	3,846 3,844 3,843	3,845 3,838 3,828	3,844 3,822 3,782	3,842 3,784 3,676	3,840 3,713 3,479
5) forest reproduction level, thousand hectares / million inhabitants (S);	0,077	0,094 0,143 0,177	0,120 0,262 0,387	0,149 0,454 0,737	0,186 0,724 1,207	0,233 1,065 1,793
6) environmental investment level, % of output (S).	0,279	0,300 0,301 0,303	0,301 0,308 0,319	0,302 0,329 0,367	0,303 0,365 0,461	0,306 0,430 0,603

We have designed three development scenarios up to 2027: inertial, realistic and optimistic (Fig. 7, *b*), which form a strategic plan for environmental sustainability – the dynamics of indicators of the environmental subsystem (Table 6).

Thus, the implementation of the realistic and optimistic scenarios ensures that the environmental component of sustainable development comes close to the optimal zone and enters the optimal zone.

5. Conclusions

The starting point for the development of institutional measures to overcome threats to sustainable development by modeling macroeconomic levers of economic growth is the methodology. It allows obtaining a scientifically substantiated list and identifying priority areas for their overcoming.

The article suggests the methodology and model calculations of implementing priority institutional measures to overcome threats to sustainable development, the theoretical foundation of which is the macroeconomic theory: aggregate demand, aggregate supply and the general macroeconomic equilibrium model that allows modeling all the defined priority areas.

The used model of general macroeconomic equilibrium, as a modeling tool, combines the application of both Keynesian approach – *demand creates its own supply* and classical approach – *supply creates its own demand*; uses an original combination of existing economic theories and analytical modeling apparatus; calculates not scalar values but their achievements from changes in the general price level; allows calculating the volume of shadow economy and real GRP.

To decrease corruption and the level of shadowing of the economy, one suggests legislatively prohibiting the increase in prices of the supplier of goods for shell companies to no more than 5-15%, which gives a positive economic effect – the increase in nominal GRP by 16.9% on average, reducing to 15% etc. Consequently, one suggests measures to prevent corruption and reduce by legally limiting markups for shell companies to no more than 15%; it ensures the total level of shadowing of no more than 15%, which gives additional gross regional product (GRP) in 2022 amounting to 27 billion UAH to increase social security, investment and innovation expenditures; besides, the level of shadowing up to 15% gives the opportunity to add the share of wages in exit to the optimal alike of the EU countries – 0.28.

To assess the impact of stimulating innovation, scientific and technological activities on sustainable development indicators, we applied the neoclassical model in the context of neo-Keynesian theory – the price level affects economic activity. We have determined the quantitative contribution of proffit factors to state economic growth, including the innovative contribution and its specific weight, which allows us to justify the necessary amounts of innovative expenditures; the average value of innovation contribution to economic growth is 15.5%, with innovation efficiency much lower than the reproduction threshold 1 (0.13); adherence to realistic and optimistic development scenarios ensures innovation efficiency at the level of 0.89 and 21.26.

To assess the impact of the augment in the real standards and life quality of the population on sustainable development indicators, we use multipliers calculated aggregate supply function model. The article shows the resulting effect of wage increase by 1,000 UAH on macro indicators: increase in the demand for labor, increase in GRP deflator, increase in nominal GRP by 53.2 billion UAH, real GRP growth rate by 12.4 percentage points, and as a result, the increase in the main indicator of the living standards – the share of labor remuneration in the output by 1.4%.

To assess the impact of macroeconomic levers of economic growth on sustainable development indicators: 1) investment level; 2) import substitution and 3) increase in export; 4) increase in household consumption, we used the calculated multipliers to assess their quantitative impact on macro indicators and justify their necessary volumes.

We determined the state of sustainable development of the environmental subsystem, which is in the crisis zone by the end of 2022. In order to maintain the sustainable development trajectory, we have developed three scenarios of the annual strategic plan for the restoration of the environmental component and its indicators.

The suggested approach of scientific substantiation of institutional measures to overcome threats to sustainable development is versatile and suitable for any component of national security, any country, region, types of economic activities, and even enterprises. According to the calculations, the implementation of the offered measures to overcome threats to sustainable development is manifested through the enlarge in nominal and real GDP, reduce in: shadow GDP, the even of GDP shadowing, shadow wages and shadow employment, etc., i.e. improvement of key indicators of sustainable development.

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References

[1] Barbier, Edward B and Joan K Burgess 2021 Institutional quality, management and progress in achieving the SDGs *Sustainability* ***13*** 21 1798 https://doi.org/10.3390/su132111798
[2] Kjersti Granos Bardal, Matias Brynildsen Reinar, Aase Kristin Lundberg, Maiken Bjorkan 2021 Factors contributing to the implementation of the Sustainable Development Goals in regional and local planning – Norwegian experience. *Sustainability*, ***13(8)*** 4282 https://doi.org/10.3390/su13084282
[3] Awuzie B, Abuzeinab A 2019 Modelling Organisational Factors Influencing Sustainable Development Implementation Performance in Higher Education Institutions: An Interpretative Structural Modelling (ISM) Approach *Sustainability*, ***11(16)*** 4312 https://doi.org/10.3390/su11164312
[4] Hjorth P, Bagheri A 2006 Navigating towards sustainable development: A system dynamics approach. *Futures*, ***38(1)*** 74-92 https://doi.org/10.1016/j.futures.2005.04.005
[5] Martens P 2006 Sustainability: science or fiction? *Sustainability: Science, practice and policy*, ***2(1)*** 36-41 https://doi.org/10.1080/15487733.2006.11907976
[6] Espinosa A & Walker J 2017 Complexity Approach to Sustainability, A: Theory and Application 5 World Scientific.
[7] https://www.worldscientific.com/doi/pdf/10.1142/9781786342041_0001
[8] Garcia-Segura S 2021 Digitalization to achieve sustainable development goals: Steps towards a Smart Green Planet. *Science of The Total Environment*, ***794*** 148539. https://doi.org/10.1016/j.scitotenv.2021.148539
[9] Ibn-Mohammed T, Mustapha K B, Godsell J., Adamu Z, Babatunde K, Akintade D, & Koh, S C 2021 A critical analysis of the impacts of COVID-19 on the global economy and ecosystems and opportunities for circular economy strategies. *Resources, Conservation and Recycling*, ***164*** 105169 https://doi.org/10.1016/j.resconrec.2020.105169
[10] Schroeder P, Anggraeni, K & Weber U 2019 The relevance of circular economy practices to the sustainable development goals. *Journal of Industrial Ecology*, ***23(1)*** 77-95 https://doi.org/10.1111/jiec.12732
[11] Madsen H 2020 Business model innovation and the global ecosystem for sustainable development. *Journal of Cleaner Production*, ***247*** 119102 https://doi.org/10.1016/j.jclepro.2019.119102

[12] Kharazishvili Y, Lyashenko V, Bugayko D, Ustinova I, Shevchenko O, Kalinin O 2023 Justification of the identification of threats and problematic components of sustainable regional development in the security dimension. *E3S Web of Conferences* ***408*** 01028 https://doi.org/10.1051/e3sconf/202340801028
[13] Jeffrey Sachs, Felipe Larrain B 1993 Macroeconomics in the Global Economy. Pearson College Div; 1st ed. 798 p.
[14] Harrod R 1939 An essay in dynamic theory. *Economics Journal* **49(193)** 14-33..
[15] Kaldor N 1957 A model of economic growth. *Economics Journal* **67(268)** 591-624
[16] Palley T 1996 Growth theory in a Keynesian mode: Keynesian foundations for new endogenous growth theory. J. of Post Keynesian Economics ***19(1)*** 113-135
[17] Ranis G 1993 Analytics of Development: Dualism. Handbook of Development Economics 1 Amsterdam.
[18] Solow R 1956 A contribution to the theory of Economic Growth. *The Quarterly Jornal of Economics* **70(1)** 65-94
[19] Swan T 1956 Economic Growth and Capital Accumulation. Economic Record
[20] Arrow K 1962 The Economic Implications of Learning by Doing. Review of Economic Studies ***29*** 155-173
[21] Sheshinski E 1967 Optimal Accumulation with Learning by Doing. Essays on the Theory of Optimal Economic Growth. Cambridge Mass. MIT Press. 31-52
[22] Mankiv G, Romer D, Weil D 1992 A Contribution to the Empirics of Economic Growth. Quarterly Journal of Economics ***107(2)*** 407-437
[23] Lucas R 1998 On the Mechanism of Economic Development. Journal of Monetary Economics 22 July 3-42
[24] Alesina A, Rodric D 1994 Distributive Politics and Endogenous Growth. Queerly Journal of Economics. V. ***109*** 465-490
[25] Barro R, X Sala-i-Martin 2001 Economic Growth. Cambridge : MIT Press. Hicks J 1937 Mr. Keynes and the Classics: A Suggested Interpretation // Econometrica, Apr. 5 147-159.
[26] Hansen A 1949 Monetary theory and fiscal policy New York
[27] Mundell R 1963 Capital Mobility and Stabilization Under Fixed and Flexible Exchange Rates. Canadian Journal of Economics and Political Science, November
[28] Fleming M 1962 Domestic Financial Policies Under Fixed and Under Floating Exchange Rates. International Monetary Fund Staff Papers, November
[29] Friedman M 1957 A Theory of the consumption function. Princeton
[30] Baumol W 1952 The transactions demand for cash: An inventory approach Quart, J.Econ 66
[31] Tobin J 1956 The interest-elasticity of transactions demand for cash Rev. Econ. Stat 38
[32] Yushchenko V, Lysitskyi V 1998 Money: Development of Demand and Supply in Ukraine K Treasures
[33] Tinbergen J, Hendricus Cornelis Bos 1962 Mathematical models of economic growth. McGraw-Hill
[34] Kharazishvili Y, Bugayko D, Yashchyshyna I, Butorina I, Androshchuk I, Sribnyi O 2023 IOP Conference Series: Earth and Environmental Science ***1126 (1)*** 0120007 DOI: 10.1088/1755-1315/1126/1/012007
[35] Friedrich Schneider 2010 Size and Development of the Shadow Economy of 31 European Countries from 2003 to 2010 July. (http://www.econ. jku.at/members/Schneider/files/publications/LatestResearch2010/ShadeEurope31_Sept2010_ RevisedVersion.pdf)
[36] Kharazishvili Y, Kwilinski A, Grishnova O, Dzwigol H 2020 Social Safety of Society for Developing Countries to Meet Sustainable Development Standards: Indicators, Level, Strategic Benchmarks (with Calculations Based on the Case Study of Ukraine) *Sustainability* ***12*** 8953
[37] Solow R 1991 Growth Theory. Companion to Contemporary Economic Thought. London 393-415

[38] Miller R, VanHoose D 1993 Modern Money Banking. Edition 3 Publisher, McGraw-Hill. Length
[39] Keynes J 1936 The General Theory of Employment, Interest and Money. Polygraphic Company of America, New York
[40] Hutsaliuk O, Havrylova N, Alibekova B, Rakayeva A, Bondar Iu, Kovalenko Y 2023 Management of renewable resources in the energy sector: environmental, economic and financial aspects. *Green Energy and Technology.* Circular Economy for Renewable Energy Springer 69-89 https://doi.org/10.1007/978-3-031-30800-0_5
[41] Hutsaliuk O, Bondar Iu, Kotsiurba O, Ostapenko O, Skoptsov K, Boiko O 2023 Factor-criteria assessment of greening prerequisites for transport infrastructure development in Ukraine IOP Conference Series: Earth and Environmental Science ***1126(1)*** 012009 DOI: 10.1088/1755-1315/1126/1/012009
[42] Mikhno I, Koval V, Khaustova Y, Järvis M, Gudz P, Gudz M and Kostiukov V 2023 Smart projects on the development of green intellectual capital in eco-industrial parks *E3S Web Conf.* **408** 01020
[43] Shmatko N, Bondar Iu, Tokareva V, Kovalenko N, Klenin O and Kotlybai V 2021 Project management as a development tool for greening of enterprises of the national economy. IOP Conf. Series: Earth and Environmental Science ***915*** 012037. https://doi:10.1088/1755-1315/915/1/012037
[44] Arsawan I W E, Koval V, Duginets G, Kalinin O and Korostova I 2021 The impact of green innovation on environmental performance of SMEs in an emerging economy *E3S Web Conf. **255*** 01012
[45] Duginets A, Shvydanenko O, Busarieva T, Balanovska T and Gogulya O 2023 Specific modern features of the transformation of the knowledge component of tnc *Financ. Credit Act. Probl. Theory Pract. **2*** 384-97
[46] Cortés J, Guix M, & Carbonell K 2021 Innovation for sustainability in the Global South: Bibliometric findings from management & business and STEM (science, technology, engineering and mathematics) fields in developing countries Heliyon ***7(8)***, e07809 https://doi.org/10.1016/j.heliyon.2021.e07809
[47] Hysa E, Kruja A, Rehman N and Laurenti R 2020 Circular Economy Innovation and Environmental Sustainability Impact on Economic Growth: An Integrated Model for Sustainable Development Sustainability ***12(12)*** 4831 https://doi.org/10.3390/su12124831
[48] Mohammad-Hosseinpour A and Molina J L 2022 Improving the Sustainability of Urban Water Management through Innovative Groundwater Recharge System (GRS). Sustainability ***14*** 5990 https://doi.org/10.3390/su14105990
[49] Zhang M, Peng C, Shu J and Lin Y 2022 Territorial Resilience of Metropolitan Regions: A Conceptual Framework, Recognition Methodologies and Planning Response – A Case Study of Wuhan Metropolitan Region International Journal of Environmental Research and Public Health ***19(4)*** 1914 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8872376/
[50] Li Q, Yan G and Yu C 2022 A Novel Multi-Factor Three-Step Feature Selection and Deep Learning Framework for Regional GDP Prediction: Evidence from China Sustainability (Switzerland) ***14(8)*** 4408 https://www.mdpi.com/2071-1050/14/8/4408/htm