Journal of Life Economics

RESILIENCE INDICATORS FOR MEASURING SUSTAINABLE ECONOMIC DEVELOPMENT

Sergii BURLUTSKI
(Doc.Sc. in Economics, Professor, Academician of Academy of Economic Sciences of Ukraine, Department of Enterprise economy, Donbass state engineering academy, Kramatorsk,/ Ukraine, E-mail: magistrdr@gmail.com**)**

Svetlana BURLUTSKA
(Doc.Sc. in Economics, Associate Professor, Department of accounting and audit, Donbass state engineering academy, Kramatorsk / Ukraine, E-mail: lanavb75@gmail.com)

Victoriya MARGASOVA
(Doc.Sc. in Economics, Professor, Department of Accounting, Taxation and Audit, Chernihiv National University of Technology, Chernihiv / Ukraine, E-mail: viktoriya.margasova@gmail.com)

ABSTRACT

The aim of this paper is to address to research the consistent patterns of the sustainable development of socio-economic systems. Theoretical explanation of this hypothesis has empirical verification by means of the research of the socio-economic system behavior of Ukraine. The analysis results of the systems of differential equations (the analogue the Lotka–Volterra equations) and the transformation of the phase space in the temporal mode for individual products indicate the possibility of existence of periodic fluctuations of output, means of production (commodity X) and consumption goods (commodity Y). The paper proposes to identify the resilience indicators for measuring sustainable economic development. Methodical recommendations on forecasting of changes trends in the "ecological" concept of resilience are tested focusing on depending on the level of the index post-shock recovery.

Keywords: *sustainable development, gross capital formation, final consumption, periodic fluctuations of output, resilience indicators, elasticity determinants*

JEL code: *C22, C62, D60, E20, E32*

1. INTRODUCTION

The activation of globalization processes transforms the world economy to a new format development. These conditions are characterized by significant uncertainties and systematic effects of the perturbations, both internal and external origin. We live in an increasingly uncertain, volatile, and risk-prone world, one that is subject to seemingly ever more pronounced disruptions and disturbances (Zolli and Healey, 2012).The nature of these disturbances has variety of types: recessions, currency crises, natural disaster, major policy changes, technological breakthroughs and etc. In addition to national or global disturbances, there are locally-originating and locally-specific disruptions such as the closure or relocation of a major employer or even the local shut-down of a whole industry. Given this rise and spread of the perturbations, it is very difficult to ensure sustainable development of national economies.

The professional community still does not have comprehensive information regarding the institutional mechanisms responsible for the economic stability and ways to strengthen it, despite the high meaning of this imperfection for society. The problem is compounded by the limitation of knowledge regarding the specifics of institutional interaction of the superstructure with the economic basis and, accordingly, a deficiency in the government strategy aimed at reducing both the frequency and strength of shocks. Hence note that the shocks should not be regarded as exclusive or common factor of failure of government economic policy.

2. LITERATURES REVIEW

Research in this field can be divided into several thematic topics. The first concentrates on problems of equilibrium socio-economic system and its components (sectors and markets). The concept of general equilibrium of a socio-economic system dates back to Walras (1874), who highlighted how to determine a set of prices which implies the equilibrium of all the markets, and where each price matches the cost of production of each commodity. More recently Arrow and Debreu (1954) formalized this concept to adapt its application to real socio-economic system. Over the past 10 years, other scholars have begun to take up this idea in their works: Bellù (2009), Peters (2012), Anderies (2013) Borghesi (2013), et al.

The second direction in the study of General economic equilibrium associated with the works of the neoclassical synthesis, which is associated primarily with the work of the American economists of the second half of the 20th century (see, e.g. Hicks, 1950; Samuelson, 1967; Lucas, 1981; Kydland and Prescott, 1982; Friedman, 1993).

Over the past few years a new key topic in the study of the dynamics of spatial socio-economic systems has been used in diverse contexts. The main economic discourse has concerned system`s ability to respond to shocks, disturbances and perturbations. Business scholars and regional analysts have begun to take up this problem in their works. The growth and spread of such attention has been stimulated by several factors: major natural environmental disasters and terrorism (see, e.g. Rose, 2005; Perrings, 2006; Heltberg, 2009); an importance of an evolutionary perspective within economic geography (see, e.g., Martin, 2013; Plotnikov, 2013); the deep financial and economic global crisis of the over 2008–2010, and the policies of restoring public finances (see, e.g. Cerra, 2009; Knudsen, 2011; Augustine et al., 2013;).

Taking into account the theoretical and practical value of these research programs, we have noted that key issues of sustainable development of the national socio-economic systems in terms of endogenous and exogenous perturbations and shocks disturbances need discussion and final resolution. Our paper is intended to move that discussion forward.

3. RESEARCH METHOD

Provide a mechanism for the implementation of the developed Strategy of Sustainable Development requires the specification of analytical and methodological support for the components correspondingly to Strategy`s functioning. This necessitates the formation of organizational-methodical approach to the monitoring of sustainable development indicators of national socio-economic system. As mentioned earlier, key economic aspects of resilience are the nature of economic growth and stability distribution of income between economic agents. The bases for the elaboration of organizational and methodological support of the monitoring process are interrelated theses which are proven in the previous papers.

Firstly, equitable distribution of wealth (national income) increases aggregate demand in the economy, despite massive inequality negatively affects the labor force productivity. Secondly, dependence on a narrow range of natural resources (resource potential ecological subsystem) reduces the incomes stability. Thirdly, reliability and sufficient resilience of the economic subsystem are provided due to productivity, diversity of natural resources in a balanced labor and a capital market. The parameters of sustainable development are caused by positive effects of investments in human capital and technological development in the conditions of realization of stable social and economic policy.

The main purpose of resilience indicators of sustainable development subsystem is the effectiveness assessment of the implementation of the Sustainable Development Strategy, derived from its program and plans, and the identification of development trends of the economic component`s parameters of national socio-economic system.

Given that the national socio-economic system as an organic unity retains its self-organization and the system`s attributes in the terms of " fluctuation movements" (changes) of its elements and their interconnections, it is proposed to use the Lotka–Volterra suitable model. This concept has been used as the basis of a methodological approach to monitoring resilience indicators and theoretically justified in our previous research (Burlutski, et al., 2015, 2016; Kovalov et al., 2017):

$$\left.\begin{aligned} \frac{dX(t)}{dt} &= \alpha X(t) - \gamma Y(t) X(t); \\ \frac{dY(t)}{dt} &= \delta X(t) Y(t) - \beta Y(t). \end{aligned}\right\} \qquad (1)$$

where the X(t) is the time series of the aggregate volume of investment goods in the valuation; the Y(t) is the time series of the aggregate volume of consumption goods in the valuation.

We may suppose a means of production (goods X) and consumption goods (commodity Y) are carried out in a closed, but dynamic (capable of self-development) system.

These basic provisions are very similar to assumptions of two-sector reproduction model of Marx, but the relationship between the dynamics of production and consumption of the means of production and consumer goods is not linear. It is necessary to take into account same assumptions for form the model:

1) to simplify the model the factor limiting the resource base is not taken into account. It does not distort the economic meaning of the model in the context of postkeynesian assumptions (as part of the existing institutional individualism methodology) resources are limited only in the long run period but in the short run period resources are inadequate using;

2) the quantity of goods and services X and Y is considered as a continuous function of time that ensures the application of differential calculus methods;

3) the means of production of X in its content provide investment products both actual manufacturing and production of consumer goods and hence the production rate is directly proportional (growth proportionality ratio "α") to the initial quantity (value).

4) for a fixed quantity of consumer goods Y consumption is equable and directly proportional initial quantity (value) (reduction proportionality ratio "β") and hence the rate of change of their quantity (value) is a negative value.

5) given that the means of production use both in own production and in the production of consumer goods, the growth proportionality ratio "α" will be reduced by the amount proportional to the consumer goods volume (a reduction ratio of growth proportionality "γ");

6) given the previous assumption, the additional means of production, directed to the consumer goods sector production will reduce the reduction proportionality ratio "β". Consequently, the reduction rate of the volume (value) of consumer goods will decrease and under certain conditions can become a positive value.

This model characterizes the dynamic equilibrium of the system – the balance between integrity and its violation, and both illustrates the distribution of national income and the efficiency of investment in the national economy.

Obtained dependences according to (1) and statistics are sufficient for the formulation of the Cauchy Problem for an approximate solution of system of first order linear differential equations with initial conditions $X_{(0)}=Xf_{(0)}$ = 5138 million USD and $Y_{(0)}=Yf_{(0)}$=34178 million USD.

The formalization of this problem in the software Mathcad 15.0 (Parametric Technology Corporation) provides the formation of the vector of unknown coefficients of the Lotka–Volterra model and the use of the operator of differential equations solutions. The model discretization is taken for 10 periods per year when the actual update frequency of the time series once per quarter (4 per year).

$$S(\alpha,\gamma,\delta,\beta) := Odesolve\left[\begin{pmatrix} X \\ Y \end{pmatrix}, t, \max(tf)\right] \qquad (2)$$

Built-in function of Mathcad "Odesolve" provides the solution of differential equation system (1) by the Runge–Kutta method with fixed step and finding the coefficient vector S (function 2). Additionally it is necessary to enter the initial (expected) vector S. Selection is repeated until a valid approximation error is obtained:

$$Given\left|\begin{array}{l}\begin{pmatrix}X\\Y\end{pmatrix}\leftarrow S(\alpha,\gamma,\delta,\beta)=augment(Xf,Yf)\\ \qquad augment(\overrightarrow{X(tf)},\overrightarrow{Y(tf)})\end{array}\right. \quad (3)$$

The actual values of volumes of the final consumption expenditure (Y) and gross savings (X) are transformed into the array by function "augment":

$$\begin{pmatrix}\alpha\\ \gamma\\ \delta\\ \beta\end{pmatrix}:=Minerr(\alpha,\gamma,\delta,\beta) \quad (4)$$

The combination of the functions (3), (4) and the function "Minerr" allows to obtain the final result of solving the system of first order linear differential equations (1):

$$\begin{pmatrix}\alpha\\ \gamma\\ \delta\\ \beta\end{pmatrix}:=\begin{pmatrix}2,6962\\ 7,0146\times10^{-5}\\ 3,0328\times10^{-5}\\ 0,1668\end{pmatrix} \quad 5)$$

$$\left.\begin{array}{l}\dfrac{dX(t)}{dt}=2,6962X(t)-7,0146\times10^{-5}Y(t)X(t);\\ \dfrac{dY(t)}{dt}=3,0328\times10^{-5}X(t)Y(t)-0,1668Y(t).\end{array}\right\} \quad (6)$$

4. EMPIRICAL RESULTS

The coefficients of equation (6) indicate that 1 currency unit in gross savings has the potential to generate in the next period (quarter) additional investment goods to the amount of 2.6962 currency units.

Likewise, the need to channel part of the funds to the expansion of consumption reduces the rate by 3.0328×10^{-5} units of the multiplier indicator Y(t)X(t). Also there is a tendency to reduction of volumes consumption goods (due to the direct process of aggregate consumption expenditure) at the rate of 16,68 per cent per quarter in the national economy of Ukraine. Investment of the same share of gross savings in the production of consumption goods slows down this process by 3.0328×10^{-5} units of the multiplier indicator Y(t)X(t).

The dialectic «consumption-investment» determines fluctuation movement parameters of the social-economic system theoretically grounded in our early papers (Burlutski, et al., 2015, 2016; Kovalov et al., 2017). Obtained differential equations provide an approximate calculation of functions values in consumption expenditure Y=f(t) and investment X=f(t). So, if the actual value of $Xf(t_0)$ is known in arbitrary point t_0 and its derivative is $dX_{(t0)}/dt$, the values of the functions X(t) at the point (t0+Δt) will be defined:

$$\Delta X=f(t_0+\Delta t)-f(t_0); \quad dX=f'(t_0)\Delta t;$$

$$X(t_0+\Delta t)\approx X(t_0)+\frac{dX(t_0)}{dt}\Delta t\,. \qquad (7)$$

A similar equation for consumption expenditure is:

$$Y(t_0+\Delta t)\approx Y(t_0)+\frac{dY(t_0)}{dt}\Delta t\,. \qquad (8)$$

Doubling the level of discretization in the simulation of the functions of consumption expenditure and investment allows to obtain the corresponding time series with the previously established initial conditions: $X_{(t=0)}=Xf_{(t=0)}$ = 5138 million USD; $Y_{(t=0)}=Yf_{(t=0)}$ = 34178 million USD:

$$\left.\begin{aligned}&\frac{dX(t_0)}{dt}=2,6962X(t_0)-7,0146\times10^{-5}Y(t_0)X(t_0)=\\&=2,6962\times5138-7,0146\times10^{-5}\times34178\times5138=1534,978;\\&\frac{dY(t_0)}{dt}=3,0328\times10^{-5}X(t_0)Y(t_0)-0,1668Y(t_0)=\\&=3,0328\times10^{-5}\times34178\times5138-0,1668\times34178=-375,095.\end{aligned}\right\} \qquad (9)$$

According to functions 7, 8, differential value consumption and investment goods at time zero is 1534,978 million USD and (-375,095) million USD. According to the doubling rate of discretization, 50 per cent of the calculated values of the differentials (the function 9) form the initial conditions at time t_0+0,5.

$$\left.\begin{aligned}&X(t_0+0,5)\approx X(t_0)+\frac{dX(t_0)}{dt}\times0,5=5138+1534,978\times0,5=5905,489;\\&Y(t_0+0,5)\approx Y(t_0)+\frac{dY(t_0)}{dt}\times0,5=34178+(-375,095)\times0,5=33990,453.\end{aligned}\right\} \qquad (10)$$

The procedure of determination of differentials is repeated and accordingly 50 per cent of the 1841,965 million USD of gross savings and 418,139 million USD of consumption expenditures form the value of $X(t_0+1)$, $Y(t_0+1)$.

$$\left.\begin{aligned}&\frac{dX(t_0+0,5)}{dt}=2,6962X(t_0+0,5)-7,0146\times10^{-5}Y(t_0+0,5)X(t_0+0,5)=\\&=2,6962\times5905,489-7,0146\times10^{-5}\times33990,453\times5905,489=1841,956;\\&\frac{dY(t+0,5)}{dt}=3,0328\times10^{-5}X(t_0+0,5)Y(t_0+0,5)-0,1668Y(t_0+0,5)=\\&=3,0328\times10^{-5}\times333990,453\times5905,489-0,1668\times333990,453=418,139.\end{aligned}\right\}$$

$$\left.\begin{aligned}&X(t_0+1)\approx X(t_0+0,5)+\frac{dX(t_0+0,5)}{dt}\times0,5=5905,489+1841,956\times0,5=6826,467;\\&Y(t_0+1)\approx Y(t_0+0,5)+\frac{dY(t_0+0,5)}{dt}\times0,5=33990,453+418,139\times0,5=34199,523.\end{aligned}\right\}$$

A similar procedure according to functions (9, 10) for other points allows modeling the phase trajectory. The obtained equation (1) suggests that the phase trajectory of the volume of goods X and Y is a closed integral curve (Fig. 1) with a nominal center in the point "O" with coordinates:

$$X_0 = \frac{0,1668}{3,0328 \times 10^{-5}} = 5499,868 \text{ million USD}; \; Y_0 = \frac{2,6962}{7,0146 \times 10^{-5}} = 38436,974 \text{ million USD.}$$

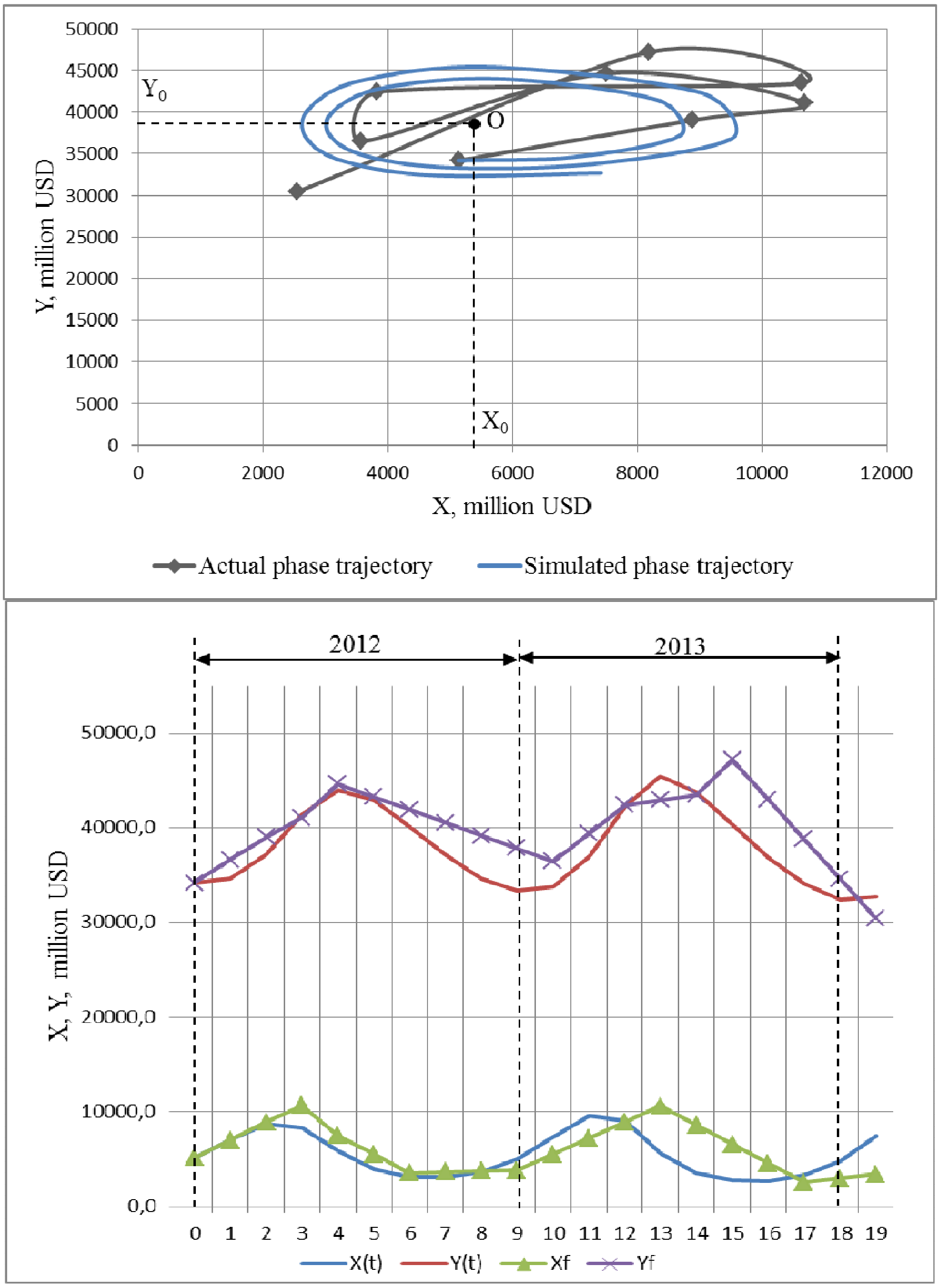

Fig. 1. The phase trajectory of the actual and simulated volumes of the final consumption expenditure (Y) and gross savings (X), million USD

Source: Author`s preparation

Actual and modeled phase trajectory is almost identical, which confirms the accuracy of the simulation. To accurately assess the quality of the model assumes the use of the parameter of average absolute error in percent:

$$MAPE_Y = \frac{1}{N}\sum_{t=0}^{N-1}\frac{|Yf(t)-Y(t)|}{Yf(t)}\times 100\%, \quad MAPE_X = \frac{1}{N}\sum_{t=0}^{N-1}\frac{|Xf(t)-X(t)|}{Xf(t)}\times 100\%. \quad (11)$$

The results of calculations are set below. To factor of gross saving is 9,9 per cent and % to consumption expenditure is 6,2 per cent. This is an acceptable value compared with the permissible approximation error of 8-10 per cent. The procedure of calculations according to the formulas 2-11 should be repeated in case of exceeding of the acceptable error range.

The parameters of the system of the Lotka–Volterra differential equations within certain trends of "ecological" interpretation of the concept of resilience (Burlutski et al., 2016) differ significantly (tab. 1). The coefficients of the Lotka–Volterra system equations can be used as indicators of changes in the resilience response of the socio-economic system. Firstly, the socio-economic system tends to a conditional point of equilibrium, but in fact fluctuates around it within the margin of the phase trajectory.

Table 1. The System of Equations of the Modified Model Lotka–Volterra for Determinate Trends of "Ecological" Interpretation of the Resilience Concept

<table>
<tr><th colspan="2">Period</th><th>System of Differential Equations</th><th>Equilibrium points, million USD</th><th colspan="2">$E_{\beta\delta}$</th></tr>
<tr><td rowspan="2">Pre-shock</td><td>2006–2007</td><td>$\frac{dX(t)}{dt}=1,0058X(t)-4,3385\times10^{-5}Y(t)X(t);$
$\frac{dY(t)}{dt}=6,2419\times10^{-5}X(t)Y(t)-0,3738Y(t).$</td><td>$X_0$=5988,561
Y_0=23183,128</td><td rowspan="2">2,2292</td><td></td></tr>
<tr><td>2007–2008</td><td>$\frac{dX(t)}{dt}=0,7919X(t)-2,7048\times10^{-5}Y(t)X(t);$
$\frac{dY(t)}{dt}=7,6043\times10^{-5}X(t)Y(t)-0,5837Y(t).$</td><td>$X_0$=7675,920
Y_0=29277,581</td><td rowspan="2">0,9994</td></tr>
<tr><td>Shock</td><td>2008–2009</td><td>$\frac{dX(t)}{dt}=0,6243X(t)-2,3613\times10^{-5}Y(t)X(t);$
$\frac{dY(t)}{dt}=7,6905\times10^{-6}X(t)Y(t)-0,0592Y(t).$</td><td>$X_0$=7697,891
Y_0=26438,826</td><td rowspan="2">0,6609</td></tr>
<tr><td rowspan="2">Post-shocr (A)</td><td>2009–2010</td><td>$\frac{dX(t)}{dt}=2,3382X(t)-9,167\times10^{-5}Y(t)X(t);$
$\frac{dY(t)}{dt}=4,4123\times10^{-5}X(t)Y(t)-0,162Y(t).$</td><td>$X_0$=3671,554
Y_0=25506,709</td><td rowspan="2">1,2524</td></tr>
<tr><td>2010–2011</td><td>$\frac{dX(t)}{dt}=2,2637X(t)-7,4557\times10^{-5}Y(t)X(t);$
$\frac{dY(t)}{dt}=4,0964\times10^{-5}X(t)Y(t)-0,1778Y(t).$</td><td>$X_0$=4349,396
Y_0=30362,005</td><td rowspan="2">0,0940</td></tr>
<tr><td rowspan="2">Post-shock (B)</td><td>2011–2012</td><td>$\frac{dX(t)}{dt}=2,1802X(t)-6,1758\times10^{-5}Y(t)X(t);$
$\frac{dY(t)}{dt}=3,2106\times10^{-5}X(t)Y(t)-0,1819Y(t).$</td><td>$X_0$=5665,607
Y_0=35302,309</td><td rowspan="2">0,5206</td></tr>
<tr><td>2012–2013</td><td>$\frac{dX(t)}{dt}=2,6962X(t)-7,0146\times10^{-5}Y(t)X(t);$
$\frac{dY(t)}{dt}=3,0328\times10^{-5}X(t)Y(t)-0,1668Y(t).$</td><td>$X_0$=5499,868
Y_0=38436,974</td><td rowspan="2">0,0230</td></tr>
<tr><td>Shock</td><td>2013–2014</td><td>$\frac{dX(t)}{dt}=-0,1531X(t)-(-5,5554\times10^{-6})Y(t)X(t);$
$\frac{dY(t)}{dt}=3,84\times10^{-5}X(t)Y(t)-0,1659Y(t).$</td><td>$X_0$=4320,312
Y_0=27558,772</td><td></td></tr>
</table>

Source: Author`s preparation

Thus, the analysis of elasticity determinants of the conditional equilibrium points (X_0, Y_0) gives the identification of the forecasted changes in the trend of the development of the national economy. Secondly, the comparison of indices of changes in gross savings (investment) and aggregate consumption show the speed of appearance of new development trends. Elasticity determinants of conditional equilibrium points will be determined by the formula of arc elasticity:

$$E_{\beta\delta} = \left| \frac{\beta_2 - \beta_1}{\beta_2 + \beta_1} \div \frac{\delta_2 - \delta_1}{\delta_2 + \delta_1} \right|, \quad E_{\alpha\gamma} = \left| \frac{\alpha_2 - \alpha_1}{\gamma_2 + \gamma_1} \div \frac{\delta_2 - \delta_1}{\gamma_2 + \gamma_1} \right|, \tag{12}$$

where α_1, β_1, γ_1, δ_1 are the coefficients of the Lotka–Volterra model for the current period (trend); α_2, β_2, γ_2, δ_2 are the coefficients of the Lotka–Volterra model for the next period (trend).

For example, the calculation according to the obtained function 2 for the transition periods between determinate trends of "ecological" interpretation of the resilience concept indicates some stable dependence.

Inelastic indicator value ($E_{\beta\delta}<1$) indicates a trend towards a trajectory with a low level of resilience in the post-shock period and risk of shock as a result of significant disturbance. Elastic indicator value ($E_{\beta\delta}>1$) is evidence of the transition to a more resilient development compared to the baseline trajectory.

5. CONCLUSIONS

Theoretically, it is possible we could actually have $E_{\beta\delta}=1$. It does not refer to the development of national economic system but it is system`s sustainable functioning. Similar conclusions can also be formulated for the indicator $E_{\alpha\gamma}$. Indices of changes in gross saving (investment) and aggregate consumption reflect the prevailing tendencies in the economy.

In case of an increase of the coefficient α should be stated positive expectations on the supply side and the possible increase in investment. On the other side, the increase of the coefficient β reflects the expectations on the part of aggregate demand. In this paper we have endeavored to set methodical recommendations on forecasting of changes trends in the "ecological" concept of resiliency depending on the level of the index post-shock recovery (tab. 1). But further, these recommendations ensure appropriate mechanisms to the process of state regulation of sustainable development.

The results of dialectical synthesis of methodological individualism and methodological holism (Marhasova, 2011; Burlutski et al., 2016) allow identifying the organizational and economic contradictions generated by modern formal institutions, which ultimately hinders sustainable national development. As we have noted, the gnosiological potential of the formed concept of institutional individualism provides not only the identification of reasons for failed government reforms and above all enables us to justify recommendations with a view to securing effective state regulation strategy of sustainable development of the national economy.

We have suggested that dichotomy of the formed methodological concept should be thought as definition the place and role of human in the development of systemic (institutional relations) and simultaneously identification the influence of institutions on individual behavior. Obtained parameters of the resilience dynamics of consumption expenditure and gross saving owing to simulation forecast are not only a reflection of the distribution of the domestic product, but also reflects certain pattern in the behavior of different layers of socio-economic agents.

Table 2. Forecast About the "Ecological" Trends Changes of the National Economy Development

<table>
<tr><th rowspan="2">$E_{\beta\delta}$</th><th rowspan="2">$E_{\alpha\gamma}$</th><th colspan="2">Forecast according to the estimating shocks method and index recovery</th></tr>
<tr><th>$I_{recovery} < 1$</th><th>$I_{recovery} \geq 1$</th></tr>
<tr><td>> 1</td><td>> 1</td><td rowspan="3">α↑ or β↑ - the transition to a more resilient development trend *D* with the ability to recovery;
α↑, β = const or α = const, β↑ - the transition to a less resilient development trend *A* without the possibility of recovery;</td><td rowspan="3">α↑ or β↑ - the transition to a more resilient development trend *D* after recovery;
α↑, β = const or α = const, β↑ the transition to resilient development trend *C* after recovery;</td></tr>
<tr><td>1</td><td>> 1</td></tr>
<tr><td>> 1</td><td>1</td></tr>
<tr><td>> 1</td><td>< 1</td><td rowspan="2">α↑ or β↑ - the ability to the economic recovery, the transition to a less resilient development trend *B* without the possibility of recovery;
α↓, β↓ or α, β = const - the ability to return to recession;</td><td rowspan="2">α↑, β↑ or α, β = const - the ability to maintain the actual trend;
α↓, β↓ - the ability to the economic depression</td></tr>
<tr><td>< 1</td><td>> 1</td></tr>
<tr><td>< 1</td><td>< 1</td><td colspan="2">The transition to a less resilient development trend, the threat of recession</td></tr>
<tr><td>1</td><td>1</td><td colspan="2">Stable operation, there is equal probability of transition to progressive or regressive scenario</td></tr>
</table>

Source: Author`s preparation

REFERENCES

ABUAF, N. and JORION, P., 1990, Purchasing Power Parity in the Long Run, Journal of Finance, 45, 157–174.

ADLER, M. and LEHMAN, B., 1983, Deviations From Purchasing Power Parity in the Long Run, Journal of Finance, 38, 147-87.

ARROW, K., DEBREU, G. ,1954, Existence of Equilibrium for a Competitive Economy. Econometrica, 22(3), 265-290. DOI: 10.2307/1907353

AUGUSTINE, N., WOLMAN, H., WIAL, H., MCMILLEN, M., 2013, Regional Economic Capacity, Economic Shocks and Economic Resilience. MacArthur Foundation Network on Building Resilient Regions, Working Paper May, Institute of Government Studies, University of California, Berkeley.

BORGHESI, S., COSTANTINI, V., CRESPI F., MAZZANTI M., 2013, Environmental Innovation And Socio Economic Dynamics in Institutional and Policy Contexts. Journal of Evolutionary Economics, 23(2), 241-245. DOI 10.1007/s00191-013-0309-5

BURLUTSKI, S., BURLUTSKI, SV., 2015, The «Resources Curse» and Special Features of the Economic Growth in Ukraine. Journal of Life Economics, 3(1), 21-26. DOI dx.doi.org/10.15637/jlecon.64

BURLUTSKI, S., BURLUTSKI, SV., 2016, The Socio-economic Development of Ukrainian Economy: «Resources Curse» Phenomenon, in Berezin A. and Bezpartochnyi M. (eds), Formation Strategy of Economic Structures: the Tools and Practices. Riga: Landmark SIA, pp. 25-35.

CERRA, V., PANIZZA, U., SAXENA, S., 2009, International Evidence on Recovery Consumption. Ecological Economics, 42, 273–287.

DEBREU, G., 1959, Theory of Value: an Axiomatic Analysis of Economic Equilibrium. New York, Wiley.

FRIEDMAN, M., 1993, The ‘Plucking Model of Business Fluctuations Revisited. Economic Inquiry, 31(2), 171-177. DOI: 10.1111/j.1465-7295.1993.tb00874.x

HELTBERG, R., SIEGEL P., JORGENSEN S., 2009, Addressing Human Vulnerability to Climate Change: Toward 'No Regrets' Approach. Global Environmental Change, 19(1), 89-99. DOI:10.1016/j.gloenvcha.2008.11.003

HICKS, J.R., 1950, Contribution to the Theory of the Trade Cycle. Oxford : Clarendon Press.

KNUDSEN, E., 2011, Shadow of Trouble: The Effects of Pre-Recession Characteristics on the Severity of Recession Impact. Institute for Research in Economics and Business Administration Bergen, Working Paper No. 19/11.

KOVALEV, V., BURLUTSKIY, S., BURLUTSKA, SV., 2017, The «Resources Curse» Phenomenon in Context of Socio-Economic Transformation of Ukrainian Economy, in Głowski, P. and Kvilinskyi O. (eds), Economic Transformation in Ukraine: Comparative Analysis and European Experience. Warsaw: Consilium Sp. z o.o., pp.147–155.

KYDLAND, F., PRESCOTT, E., 1982, Time to Build and Aggregate Fluctuations. Econometrica, 50(6), 1345-1370. DOI: 10.2307/1913386

MARHASOVA, V., 2011, Theoretical & Methodological Grounds for Region's Economic Security Maintenance. Actual Problems of Economics, 124, 186-193.

MARTIN, R., 2014, Path Dependence and the Spatial Economy: A Key Concept in Retrospect and Prospect, in Fischer, M. M. and Nijkamp, P. (eds): Handbook of Regional Science. Springer, Heidelberg.DOI: 10.1007/978-3-642-23430-9_34

PERRINGS, C., 2006, Resilience and Sustainable Development. Environment and Development Economics, 11(4), 417-427. DOI:10.1017/S1355770X06003020

PETERS, R., BERRE, M. LE., POMEAU, Y., 2012, Prediction of Catastrophes: an Experimental Model. Physical Review, 86. DOI: 10.1103/PhysRevE.86.026207

PLOTNIKOV, D., 2013, Hysteresis in Unemployment and Jobless Recoveries. UCLA, Working paper. DOI: 10.5089/9781484371749.001

ROSE, A., LIAO, S-Y., 2005, Modelling Regional Economic Resilience to Disasters: a Computable General Equilibrium Model of Water Service Disruptions. Journal of Regional Science, 45, 75–112. DOI: 10.1111/j.0022-4146.2005.00365.x

SAMUELSON, PAUL A., 1967, Economics: An Introductory Analysis . New York: McGraw-Hill Book Company.

ZOLLI, A., HEALY, A., 2012, Resilience: Why Things Bounce Back. London: Headline Publishing Group.