

PECULIARITIES OF NON-LINEAR DEVELOPMENT OF UKRAINIAN ECONOMY: CAUSES AND TENDENCIES

O. Rayevnyeva

N. Dubrovina

One of the causes of non-linear development of the economies of transitional, post-socialist and developing countries is the rapid increase of public debt and the phenomenon of inflationary economic growth. Transitional and developing economies, under conditions of the lack of their own accessible credit resources, a weak domestic financial market and immaturity of the market relations, low competitiveness of national economies, effects of the shadow economy, lack of effective public control over the use of public funds, poor development of civil society institutions and total corruption, are forced to borrow from foreign governments and international lending institutions to meet their requirements. This makes them extremely vulnerable to sudden surges of foreign exchange, sensitive to global and local financial and economic crises.

The foreign debt service under the conditions of populist policy and corruption, which is often observed in countries with transitional and developing economies, is becoming an intolerable burden, leading to a snowball effect and passing the debt load onto future generations. The risk of economic default arises with a relatively low level of created added value of goods and services, their predominantly internal nature of consumption, tax evasion on the one hand and, high level of inflation, impoverishment of the population on the other hand. The research conducted by a number of scientists in various countries of the world has shown a significant influence of political and economic factors on the possibility of default for countries with unstable economies, an underdeveloped capital market and weak institutions of civil society.

The problem of studying non-linear effects in the countries of transitional economy in connection with the growth of public debt and various crises in political and economic spheres has not been sufficiently understood. Thus, scientific interest is focused on the study of the relationship of

the main macroeconomic indicators and their non-linear dynamics connected with the public debt figures, its structure and development trends, measures of government regulation and possible approaches to the prediction of the probability of default. This problem is relevant for a number of EU countries (Greece, Portugal, Spain, Ireland, etc.), and for Ukraine, where in recent years there have been complex political and socio-economic processes that determine the significant volatility and uncertainty in the possible outcomes of resolution of the crisis situation and future scenarios of the country's development.

Let us consider in more detail a number of studies related to the influence of the proliferation of public debt as one of the main sources of non-linear development of the economies of many countries. Let us represent different definitions of public debt, which reflect different understanding of the nature of public debt by some scientists.

Government debt (or public debt) is an important definition in the macroeconomic theory of finance. But in the related literature it is possible to find different understanding of these definitions.

According to the business dictionary, government debt is an aggregate value of bonds and other debt securities issued by a government (or one or more of its authorized agencies) backed by its full faith and credit [1]. N. G. Mankiw and P. Taylor characterize government debt as "governments' finance budget deficits by borrowing in the bond market, and the accumulations of past government borrowing" [2]. J. R. Barro understands public debt as a sum of the state's debt securities, intended to finance a temporary lack of funds in the state budget [3]. Government debt in the euro area countries, usually referred to as the Maastricht debt, is defined as the gross debt of general government at the nominal value outstanding at the end of the year. Government liabilities

compromise currency along with deposits, loans and securities other than shares. Government debt excludes certain financial instruments, such as financial derivatives and trade credits. O. Blanchard considers public debt as "the amount of the reserve – current debt, which government has accumulated" [4]. R. Nelson describes sovereign debt, public debt or government debt as synonyms and they mean debt incurred by governments [5]. Public or government debt can be analyzed by means of special indicators, which are expressed in absolute values or as ratios.

In the paper by Ž. Karazijiene three main groups of public or government debt indicators are considered [4]. The first group includes such general indicators as: gross domestic product (GDP); state budget expenses; state export sum. The second group of indicators consists of such a set as: public or government debt (internal and foreign); interest on the public or government debt; public or government debt per capita. The third group uses relative indicators, such as: public or government debt to GDP ratio; interest on the public (government) debt to budget expenses ratio; interest on the public (government) debt to GDP ratio; foreign debt and state export ratio; foreign debt to GDP ratio.

As mentioned in the paper by Ž. Karazijiene and in the numerous reports of the EU, the OECD, the IMF, etc., the main four criteria for evaluation of the public (government) debt acceptability level are applied. These criteria are shown in Table 1.

What are the causes of government debt? Government or public debt is closely connected with government deficit [6; 7].

Evaluation criteria of the public debt acceptability level [4]

Criteria	Definition of criteria	Acceptability limits
Public debt and GDP ratio	Provide country's economic stability level	≤ 60 % (Maastricht Treaty criteria)
Foreign debt and GDP ratio	Country's potential to return debt is assessed	≤ 30 % (IMF)
Ratio of paid interest on government debt and government revenues	The burden of country's debt is assessed	≤ 10 % (IMF)
Budget deficit and GDP ratio, %	Country's financial situation is assessed	≤ 3 % (Maastricht Treaty criteria)

Government deficit takes place when government spending is bigger than tax collections. The difference between government spending and tax collection is called government deficit. It is possible to reveal different groups of causes why government deficit increases. These are: political situations connected with forthcoming elections, expanding military expenditures for national safety programs, etc.; economic conjuncture characterized by tax and fiscal policy (reducing tax burden, expansion of social programs, government support of labor markets, health care, education, etc.), government investment programs, implementation of crucial reforms, etc.; extraordinary accidents such as large natural disasters or catastrophes, military actions or conflicts, unfavorable natural conditions for the agricultural industry, etc. [6 – 8].

Some countries accumulated huge consolidated debt, which exceeded 100 % of their GDP. In Fig. 1 the gross consolidated debt as percentage of GDP is shown.

It is used for fiscal surveillance, under the SGP, to assess whether the criterion of a government debt ratio below the "60.0 per cent of GDP" reference value is met. Fig. 1 shows that 15 out of 28 EU Member States reported debt-to-GDP ratios over the reference value of 60.0 per cent. Greece recorded the highest debt ratio at 175.1 per cent, followed by Italy at 132.6 per cent. The lowest debt-to-GDP ratio was registered by Estonia at 10.0 per cent.

Table 1

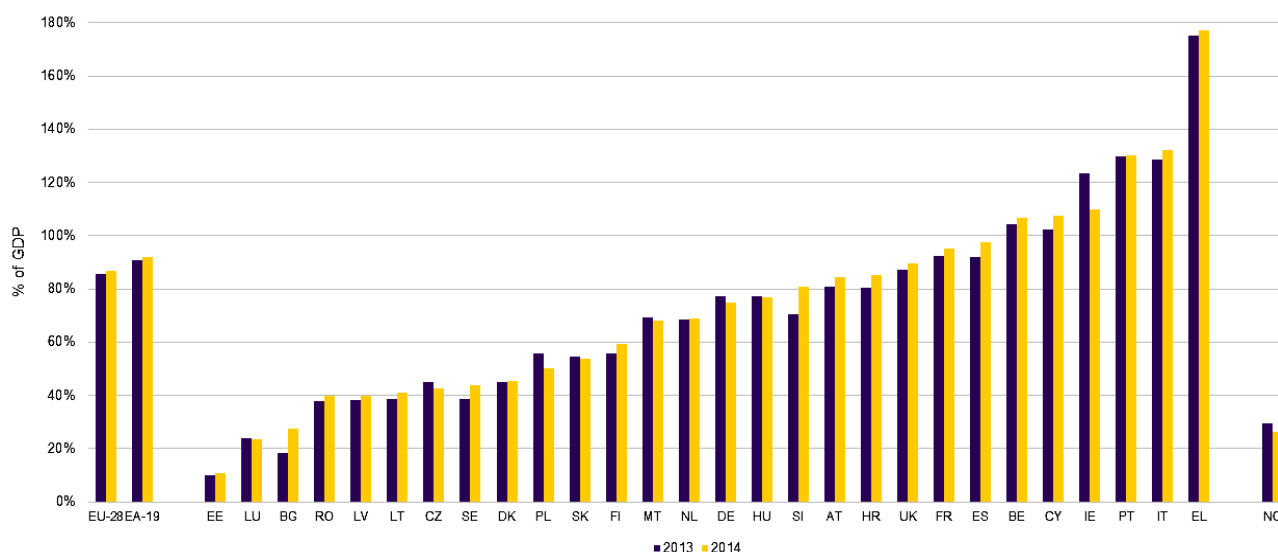


Fig 1. Gross Consolidated Debt as % to GDP, 2013 – 2014

Source: Eurostat (http://ec.europa.eu/eurostat/statisticsexplained/index.php/File:Maastricht_debt_as_a_percentage_of_GDP,_2013%E2%80%932014.png) [9]

It should be noted that a significant accumulation of government debt is closely related to the increase in its maintenance costs, which is displayed in the appropriate fiscal policy of the countries. The growth of public debt in the period of crisis during 2008 – 2011 years. most notably led to a sharp increase in fiscal spending in such countries as Greece (27.3 %); Iceland (44.2 %); Ireland (40.7 %). The part of the total government spending associated with the restructuring of the financial sector, in particular, directed to the recapitalization of banks is meant under the fiscal cost. Table 2 represents indicators of the dynamics of fiscal expenditure and the growth of public debt in 2008 – 2011, during the development of the bank, and then the systemic crisis in some EU countries.

Table 2

Indicators of the dynamics of fiscal expenditure and the growth of public debt [10]

Country	Fiscal expenditure growth, %	Public debt growth, %
1	2	3
Austria	4.9	14.8
Belgium	6.0	18.7
Denmark	1.0	24.9
Estonia	1.9	n.a.

Table 2 (the end)

1	2	3
France	1.0	17.3
Germany	1.8	17.8
Greece	27.3	44.5
Hungary	2.7	-0.3
Iceland	44.2	72.2
Ireland	40.7	72.8
Italy	0.3	8.6
Latvia	5.6	28.1
Luxemburg	7.7	14.6
Netherlands	12.7	26.8
Portugal	0.0	33.6
Slovenia	3.6	18.0
Spain	3.8	30.7

Sweden	0.7	11.1
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A number of researchers [10; 11] note the relationship of the banking crisis and a systemic crisis in some EU countries. For example, in some EU countries, the rapid growth of loans among households and real business, caused by the stimulation of consumer policy and economic growth by a populist government, was observed in recent years. The expenditure part of the state budget significantly increased, which led to the increase of its deficit. For example, in Greece, the state budget deficit was 9.1 % of GDP, in Ireland it amounted to 13.1 % of GDP, in Spain it made 8.5 % of GDP. Thus high growth of public and private spending, leveraged businesses and entrepreneurs contributed to the boom in the banking sector, which had been observed for a certain period before the start of the crisis. So, in pursuit of the demand, the banking sector provided more and more loans, thus, accounts payable grew significantly. However, the real productivity of the economy was much lower, real household incomes could not keep up with the consumer boom, and as a result, due to the influence of external financial and economic crisis and internal problems in the banking and real sectors, economies of some countries, such as Greece, Ireland, Spain faced the threat of default. Stringent restrictive measures in fiscal policy, as well as financial support from the international financial funds could save the economy of these countries.

Thus, an important area for the risk analysis is related with possible country defaults or serious crisis in debt payments. Despite government incentives to repay debt, there is a long history of governments suspending debt payments or falling behind on their debt payments, referred to as "defaulting" on their debt. A "debt crisis" typically refers to a situation where a country is either unable or unwilling to pay its debt. Defaults and debt crises can be triggered by a number of different economic and political factors, including, but not limited to, economic recessions, fluctuations in the price of imports and exports, currency depreciation (if debt is not payable in domestic currency), wars, and changes in political leadership [5].

Usually, different kinds of econometric models (logit models, regression models, structural models, etc.) are used

for the analysis of possible default risk or "debt crisis" [5; 12]. Some authors and experts of the IMF used logit models for prediction of debt crisis for different groups of countries during the period of 1970 – 2002 [13]. They applied Generalized Standard&Poor's Default Indicator as a dependent variable. The following set of indicators was used as explanatory variables: 1) total external debt in percent of GDP (entry into default, exit from default); 2) short-term debt, original maturity to reserves (entry into default, exit from default); 3) short-term debt, remaining maturity to reserves (entry into default, exit from default); 4) interest on short-term debt in percent of GDP (entry into default, exit from default); 5) external debt service to reserves (entry into default, exit from default); 6) current account balance in percent of GDP (entry into default, exit from default); 7) reserves growth (entry into default, exit from default); 8) U.S. treasury bill rate (entry into default, exit from default); 9) real GDP growth (entry into default, exit from default); 10) FDI in percent of GDP (entry into default, exit from default); 11) inflation volatility; 12) index of freedom status (entry into default, exit from default); 13) dummy variables for high inflation, past default episodes, the year of presidential election, etc.

In numerous papers it is possible to find different approaches to the analysis of debt dynamics and factors influencing government debt crisis [3 – 5; 13 – 15].

The change in the debt ratio can be decomposed according to this formula [13]:

$$(1)$$

where D_t is government debt in the time t ; Y_t is nominal GDP in the time t ; D_t^p is primary debt in the time t ; ΔD_t is stock flow adjustment in the time t ; r is an average cost of debt (interest rate) and g is nominal GDP growth. It should be noted that the term in parenthesis reflects the snowball effect.

In Table 3 the results of the decomposition, which explain increases in the debt ratio in the current crisis, are shown.

Decomposing the increases in the debt ratio in the current crisis (% of GDP) [13]

	Change in the debt ratio	Contribution to change in the ration debt ratio in 2011 with respect to 2007					
			of which	Snowball	Stock-flow adjustment		
		Primary balance	Cyclical effect	Interest expenditure	Growth effect	Inflation effect	
1	2	3	4	5	6	7	8
EU-27	25.0	12.0	3.3	11.7	0.4	-4.5	4.3
BE	19.7	2.9	3.1	15.8	-0.2	-5.6	6.8
DE	14.7	1.8	2.4	11.1	0.6	-2.5	3.7
IE	71.1	38.4	8.2	10.6	3.2	1.1	17.8

Table 3 (the end)

1	2	3	4	5	6	7	8
EL	39.9	24.2	1.0	21.2	-1.2	-9.2	4.9
ES	37.8	25.8	3.5	8.8	1.0	-2.1	4.3
FR	23.8	16.2	3.3	11.4	-0.9	-5.1	2.3
IT	14.3	-1.4	4.0	19.8	3.9	-9.6	1.5
LU	11.1	6.1	5.8	2.2	0.1	-1.1	3.9
NL	24.2	6.3	2.8	9.4	0.7	-3.3	11.1
AT	17.6	3.9	2.2	11.6	-0.6	-4.0	6.6
PT	27.5	15.0	3.9	12.4	0.9	-3.5	2.8
SI	24.8	15.5	1.8	6.6	-0.3	-2.7	5.8
FI	17.6	1.5	4.6	5.7	1.0	-2.7	12.0
MT	10.5	4.7	-0.1	13.2	-1.5	-5.7	-0.3
CY	5.1	4.9	-0.2	9.3	-2.6	-6.2	-0.3
SK	13.4	14.9	-1.0	5.3	-1.7	-4.1	-1.0
BG	-2.5	-3	3.0	3.4	-0.5	-3.0	0.5
CZ	15.0	14.2	0.5	5.7	-0.4	-2.0	-2.5
DK	8.3	0.9	8.1	5.9	0.7	-2.5	3.2
EE	9.4	10.1	5.8	1.8	0.4	-0.2	-2.7
LV	51.4	29.2	4.9	8.4	5.1	1.7	7.0
LT	32.4	25.0	4.1	6.8	3.2	-0.9	-1.8
HU	13.2	-0.4	3.6	16.4	2.6	-8.6	3.2
PL	16.3	14.3	0.9	10.8	-5.4	-5.1	1.6
RO	18.7	19.9	0.3	6.1	-0.4	-4.8	-2.1
SE	3.6	0.2	6.4	5.5	0.4	-4.3	1.9
UK	44.0	31.2	3.7	10.0	0.2	-4.5	7.3

A set of broadly similar, but separate national plans are seen from these data. The schemes approved encompass recapitalization and other forms of equity intervention, guarantees, liquidity support and impaired assets relief. Some states have adopted ad hoc interventions.

Government finances the public debt using different tools of fiscal and monetary policies. The major part of public debt is covered by issuing securities, such as: stocks, government

bonds, treasury bills, etc. Also government borrows money by means of loans or credits. So the public debt services are closely connected with the banking sector.

It should be noted that EU countries implemented some public interventions in the banking sector as a measure to react to the crisis. In Table 4 these public interventions in the banking sector are presented.

Table 4

Public interventions in the banking sector (% of GDP) [13]

	Capital injections		Guarantees on bank liabilities	Relief of impaired asset and liquidity and bank support	Total for all approved measures	Total effective for all measures	Guarantees on deposits (Euro or % of deposits)		
	Total approved measures	Effective capital injections	Total approved measures	Guarantees granted	Total approved measures	Effective interventions			
1	2	3	4	5	6	7	8	9	10
EU-27	2.7	1.7	24.6	7.9	4.1	3.0	31.4	12.7	–
BE	5.3	0.0	71.0	16.4	8.2	8.2	84.4	30.7	100,000
BG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50,000
CZ	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	50,000
DK	6.3	2.0	258.5	2.6	0.3	0.3	265.0	5.3	100 %

Table 4 (the end)

1	2	3	4	5	6	7	8	9	10
DE	4.4	0.0	18.6	7.1	1.4	1.4	24.3	10.5	100 %
EE	0.0	6.6	0.0	0.0	0.0	0.0	0.0	0.0	50,000
IE	6.7	1.6	167.5	167.5	0.0	0.0	174.2	174.1	100 %
EL	2.1	0.0	6.2	1.2	3.3	1.9	11.6	4.7	100,000
ES	0.0	1.2	19.1	4.0	2.9	1.8	21.9	5.8	100,000
FR	1.2	0.1	16.5	5.4	0.2	0.2	17.9	6.8	70,000
IT	1.3	0.1	n.a.	0.0	0.0	0.0	1.3	0.1	103,000
CY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100,000
LV	1.5	1.0	27.0	2.9	11.4	5.0	39.9	8.9	50,000
LT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100,000
LU	6.7	7.7	12.0	NR	0.9	0.9	19.5	8.5	100,000
HU	1.1	0.1	5.6	0.0	0.0	2.5	6.8	2.6	100 %
MT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100,000
NL	6.4	6.9	34.8	7.8	11.5	5.6	52.8	20.3	100,000
AT	5.5	1.7	25.6	6.8	7.0	2.0	38.1	10.5	100 %
PL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50,000
PT	2.5	0.0	10.1	3.3	0.0	0.0	12.6	3.3	100,000

RO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50,000
SI	0.0	0.5	33.8	6.5	0.0	0.0	33.8	6.9	100 %
SK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100 %
FI	0.0	0.0	28.4	0.0	0.0	0.0	28.4	0.0	50,000
SE	1.6	0.2	46.8	10.6	12.1	0.0	60.5	10.8	50,000
UK	3.5	2.6	21.6	11.2	16.3	14.6	41.4	28.4	50,000

The effect on the fiscal risk depends on the nature of the measure. For example, the capital injections appear on the government sector's balance sheet and lead to increases in gross debt via the stock-flow adjustment. Also, as it is seen from Table 4, the approved and effective guarantees were significant for some EU countries. The asset relief and liquidity and bank support schemes are a mixed set of interventions, some of which transfer risk to the public sector without an outlay that appears in debt [13].

Thus, by studying the mentioned above works, it can be concluded that public debt and various factors that determine its dynamics are the sources of uneven development of modern economies. Taking into account the fact that the Ukrainian economic system has very similar characteristics of non-linear development of the European countries with transition economies, it is necessary to conduct a more detailed study of the dynamics of public debt and its impact on the gross domestic product and inflation.

The goals of this research are: to analyze the trends in the key macroeconomic indicators (gross domestic product and inflation) and public debt dynamics, to reveal their non-linear nature, to study the reactions of these macroeconomic indicators to the external and internal shocks which have a non-stationary nature. On the basis of the econometric models for non-stationary time series and the study of random fluctuations (shocks) the forecasts of development of the Ukrainian economy have been obtained with an allowance for various scenarios.

The economic development of Ukraine, as well as a number of other post-Soviet countries, has marked features of non-linear dynamics. So, the deep decline in production and increasing crisis phenomena, observed since the beginning of the 90s, stabilized only in the 1998 – 1999, and economic growth begun to 2000 – 2001. At the same time until the 2007 – 2008 there had been periods when the annual GDP growth rate had been over 10 %. During this period there had also been a significant expansion of the sales network and banking

institutions; the population had actively used the possibilities of buying short-term and long-term goods on credit; the real estate market, especially the primary one, had been growing by mortgages provided to the population. Favorable market conditions contributed to the growth of export-oriented agricultural products, raw materials and semi-finished products, tube products, chemical fertilizers, and the production, manufacture and sale of which were favorable upon condition of cheap energy resources. This situation contributed to the growth and the accumulation of foreign exchange earnings in export enterprises and in the state. Economic growth and regulation of social and economic spheres in the period from 2000 to 2007 – 2008 led to a significant increase in the welfare of the population, an increase in consumption and retail turnover growth, demand for a variety of services (tourism, medical services in private clinics, holidays abroad, training contracts etc.). As a significant part of financial resources in Ukraine is in the so-called "shadow economy" and the main currency for payments, both among businesses and the public, is the US dollar, as a result of the economic growth in 2001 – 2008, the country had accumulated a significant portion of foreign exchange reserves, a big part of which was used by banks to provide loans and credits, both for enterprises and households. In turn, the Ukrainian banks, which did not have a significant private capitalization, borrowed more resources for the development of their business abroad. The sharp deterioration of the external financial and economic situation, connected with the global financial crisis of 2008 – 2011, the internal political crisis and irreconcilable differences among the political and business elite, had led to a new stage of development of Ukraine: changes in policy and the aggravation of relations with Russia; a change of government; internal political and territorial conflicts; jump of the dollar and the euro; decline in economic activity of enterprises, particularly small businesses; growth of unemployment rate; a series of failures of banks and large enterprises; increasing prices due to inflation; the impoverishment of vulnerable segments of the population and, as a result, a significant drop in the living standards of the population. "Overheated" economy of

Ukraine, pegged to the rate of the US dollar, on the one hand, and dependable on Russian energy resources, on the other hand, had "blown away" in a relatively short period, which was accompanied by a sharp drop in the level of real GDP and NI.

Fig. 2 shows the dynamics of GDP per capita in Ukraine for the period of 1992 – 2014 years.

Despite the attempts of the current government of Ukraine to stop the crisis in the economy and in the banking sector, it is done with difficulties and with considerable support from foreign lenders.

Fig. 2. The dynamics of GDP per capita, USD [16]

Fig. 3 and 4 show the dynamics of the official and commercial debt of Ukraine per capita over the period of 1992 – 2014 years.

Fig. 3. The dynamics of the official debt of Ukraine per capita, USD
(author's calculation based on the data, presented on the site www.ukrstat.gov.ua) [17]

Thus, the provision of the next tranche of foreign loans temporarily solves crises situations in Ukraine, at the same time, increasing the debt burden on the country's population and its future generations. At the end of 2015 the total debt of Ukraine amounted

to more than 65 billion dollars, 23.2 billion dollars of which was the official debt, and 42.1 billion dollars was commercial debt. At the same time the external debt amounts to 43.4 billion dollars (66.3 %), while domestic debt amounts to 22.1 billion dollars (22.1 %).

Fig. 4. Dynamics of the commercial debt of Ukraine per capita, USD
(author's calculation based on the data, presented on the site www.ukrstat.gov.ua) [17]

In recent years, the rapid growth of inflation in Ukraine (Fig. 5), caused by, both political and economic reasons, has led to the fact that international agencies negatively assess the rating of Ukraine. Thus, in 2013, S & P agency predicted risk of default in Ukraine in 54.34 % [5].

In the present study, an analysis of the influence of parameters of total debt (official and commercial) on the dynamics of GDP and inflation has been made.

Graphical analysis of charts of GDP per capita (1992 – 2014), inflation, official and commercial debt per capita in US dollars (Fig. 2 – 5) indicate a non-linear nature of the dynamics of their development. This is also confirmed by the results of the Augmented Dickey-Fuller test (ADF test) for a unit root, which indicate the non-stationary nature of the original time lines. For the conversion into stationary series, needed for the modelling of interaction of the processes of the GDP growth dynamics, inflation and public debt (official and commercial), second-order differences have been used.

Time series provided by the second differences of the GDP initial levels, inflation and public debt (official and

commercial) per capita, are stationary, as evidenced by the results of the ADF test.

Fig. 5. The dynamics of growth of inflation to baseline, %
(calculated from the real GDP and population in the ERS International Macroeconomic Data Set) [16]

It should be noted that in terms of the physical interpretation of dynamic processes, the second differences are analogous to the acceleration, and the first differences are analogous to the rate of change of indicators. For stationary series, presented by the second differences of baseline indicators, a vector autoregression model (VAR) was used (Table 5).

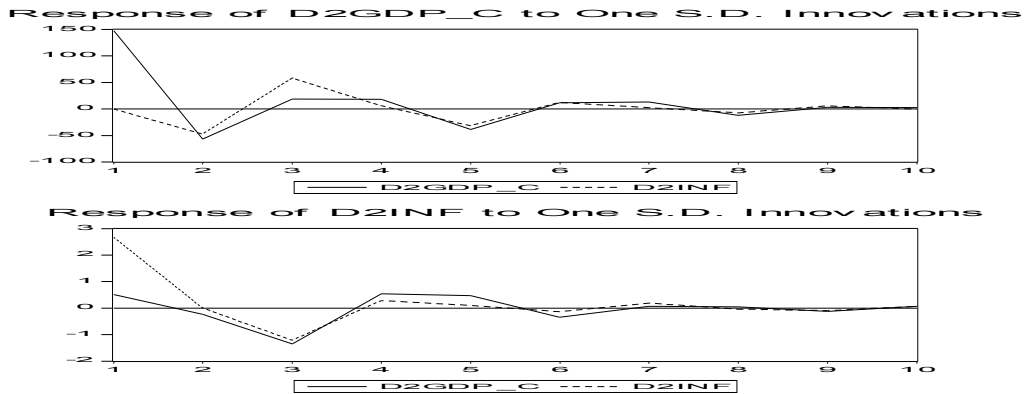
Table 5

Model of VAR in the performance of second differences in per capita GDP, inflation rate and public debt values (official and commercial) per capita (author's calculation)

1	2	3
Sample(adjusted): 5 23		
Included observations: 19 after adjusting endpoints		
Standard errors & t-statistics in parentheses		
	D2GDP_C	D2INF
D2GDP_C(-1)	-0.3253 (0.22528)	-0.0016 (0.00416)
	(-1.44393)	(-0.38509)
D2GDP_C(-2)	-0.08207 (0.22298)	-0.0081 (0.00412)
	(-0.36803)	(-1.96782)
D2INF(-1)	-17.5978 (-11.9102)	0.002059 (0.21994)

	(-1.47754)	-0.00936
D2INF(-2)	16.08778 (14.2039)	-0.4806 (0.2623)
	(1.13263)	(-1.83226)
C	10.68397 (44.2032)	0.465467 (0.81629)
	(0.2417)	(0.57022)
D2COMD_C	-0.63728 (0.56574)	0.005114 (0.01045)
	(-1.12645)	-0.48946
D2OFD_C	-1.57942 (0.83253)	0.024652 (0.01537)
	(-1.89713)	(1.60347)
R-squared	0.549344	0.529279
Adj. R-squared	0.324016	0.293919
Sum sq. resids	413111	140.8815
S.E. equation	185.5422	3.426387
F-statistic	2.437977	2.248806
Log likelihood	-121.837	-45.9929
Akaike AIC	13.56175	5.5782
Schwarz SC	13.9097	5.926151

Table 5 (the end)



	1	2	3
Mean dependent		3.460811	0.135307
S.D. dependent		225.6704	4.077643
Determinant Residual Covariance			155604
Log Likelihood			-167.493
Akaike Information Criteria			19.10451
Schwarz Criteria			19.80041

This vector autoregression model is represented by the following system of equations:

(2)

where $\Delta^2 GDP_C$ is the value of second differences of GDP per capita (USD) in the period t ; $\Delta^2 INF$ is the values of second differences of the inflation rate in the period t ; $\Delta^2 GDP_C$ are the values of second differences of commercial and official debt per capita (USD) in the period t , respectively.

As can be seen from Table 5, the values of changes in the GDP per capita and inflation rate depend on their previous values and changes in commercial and official debt per capita. The growth of the second differences of commercial and official debt per capita leads to a decrease in the current values of second differences in the GDP per capita, as evidenced by the negative estimated parameters in Table 5, and an increase in the second differences of the inflation rate (positive estimated parameters). Thus, a significant increase in the acceleration of public debt per capita in Ukraine has led to a slowdown in the GDP growth per capita and an increased rate of inflation.

In general, the built vector autoregression model has shown a significant connection between the indicators of change in the GDP per capita, inflation and public debt (official and commercial) per capita, as evidenced by the relatively high correlation indices bigger than 0.5. At the same time, one cannot underestimate the influence of random exogenous shocks in this model. Pulse analysis has been carried out to study their effects, the results of which are shown in Fig. 6.

Fig. 6. Impulse analysis of responses of the dependent variable of the vector autoregression model on their one standard deviation (S.D. Innovations)

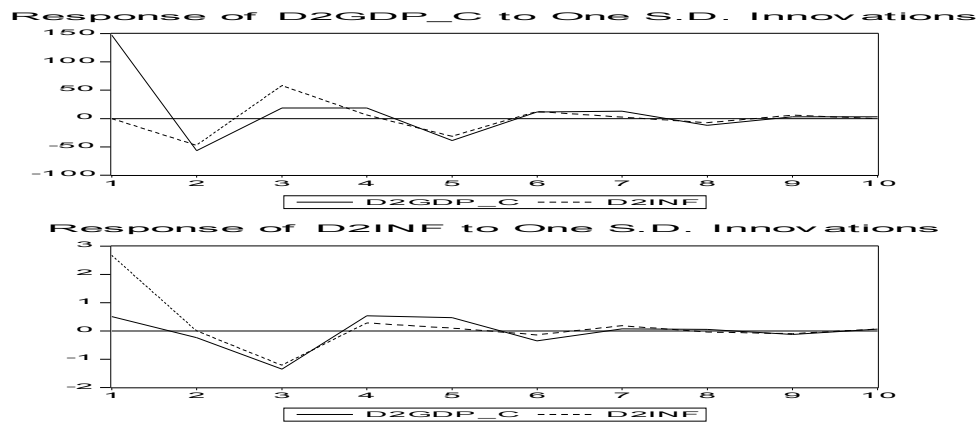


Fig. 6. (the end)

As can be seen, the oscillation of parameters is damped, but damping occurs only after a lag of 7 – 8 periods of time (years). Thus, even short-term, but significant changes in the dynamics of in the model macroeconomic indicators studied affect their future value within 7 – 8 years.

Since one of the factors causing instability in the economic development of many modern economic systems, is the national debt, it is necessary to pay special attention to the analysis and modelling of its dynamics.

Trends reflecting the dynamics of the official and commercial debt in Ukraine have been analyzed in this study (Fig. 7). As can be seen from the visual analysis of the dynamics of these indicators, their trends are presented by non-linear functions.

Fig. 7. The dynamics of the commercial and official national debt of Ukraine (bn USD) [17]

Let us represent the results of modelling of the dynamics of the official national debt of Ukraine (bn USD) for the period of 1992 – 2015 years. Based on the properties of

the graph of the dynamics of these indicators (Fig. 8) a non-linear trend model was constructed, expressed by a polynomial of the third degree (Table 6).

Fig. 8. The graph of the dynamics of the official national debt of Ukraine (bn USD)

Table 6

The model of the dynamics of the official debt of Ukraine for the period 1992 – 2015, expressed by the third degree polynomial

Model: dofic=a0+a1*t+a2*t^2+a3*t^3 (new_debt_ukraina.sta)				
Dep. var: DOFIC Loss: (OBS-PRED)**2				
Final loss: 249.51724774 R=.81393 Variance explained: 66.248 %				
	A0	A1	A2	A3
Estimate	4.484445	0.885229	-0.06291	0.002368

As can be seen from the table data, the presented model of the non-linear trend fairly well approximates the baseline indicators, as evidenced by a high correlation coefficient (0.8).

At the same time, the study of the model residuals presented in Fig. 9, indicates their unsteady nature.

Fig. 9. The graph of the model's residuals represented by a polynomial trend

The model residuals that are interpreted as the influence of various exogenous shocks are autocorrelated and the variation of their values has increased since 2007. As soon as the study of the nature of non-stationary residuals data and response to exogenous shocks, represents

a separate scientific interest for the modelling of dynamics of the official public debt, the following approach was used. For the model residuals data, third differences were obtained, which largely had the required stationary conditions of time series (Fig. 10).

Fig. 10. The graph of third differences of the model's residuals of the polynomial trend

For the simulation of the dynamics of the values of this time series the moving average (MA), presented in Table 7 was used.

Table 7

The model of the moving average for the third differences of the model's residuals of the dynamics of the official debt

Input: DELT3RS3 (new_debt_ukraina.sta)						
Transformations: none						
Model:(0,0,1) MS Residual=13.538						
		Asympt.	Asympt.		Lower	Upper
	Param.	Std.Err.	t(20)	p	95 % Conf	95 % Conf
q(1)	0.955265	0.077027	12.40164	7.58E-11	0.794589	1.115941

On the basis of this model, predicted values of the influence of exogenous shocks on the indicators of the official public debt were obtained (Table 8).

Table 8

The forecast of the third difference values for residuals of the dynamics of the official debt (based on the model of the moving average) for 2016 – 2018 years

Forecasts; Model:(0,0,1) Seasonal lag: 12				
Input: DELT3RS3				
Start of origin: 1 End of origin: 21				
		Lower	Upper	
	Forecast	90.0000 %	90.0000 %	Std.Err.
22 (2016)	-3.23244	-9.57839	3.113513	3.679415
23 (2017)	0	-8.77609	8.776092	5.08842
24 (2018)	0	-8.77609	8.776092	5.08842

A similar approach was used to model the dynamics of the commercial public debt of Ukraine (bn USD). The graph of the dynamics of these parameters is shown in Fig. 11.

Fig. 11. **The graph of the dynamics of the commercial public debt of Ukraine (bn USD)**

As seen from the graph, the trend is not linear, so in view of its features, a power function was chosen for the trend model. The results of building a trend model for the dynamics of values of the commercial public debt of Ukraine are presented in Table 9.

Table 9

The model of the dynamics of the commercial debt of Ukraine for the period of 1992 – 2015 years

Model: $dkomm=a_0*t^{a_1}$ (new_debt_ukraina.sta)		
Dep. var: DKOMM Loss: (OBS-PRED)**2		
Final loss: 786.89006599 R=.94836 Variance explained: 89.938%		

	A0	A1
Estimate	0.003215	3.083187

The residuals of this model are also transient in nature (Fig. 12) so to model the exogenous shocks related to the dynamics of residuals, their third differences were used (Fig. 13), which largely met the requirements of stationary time series.

Fig. 12. The graph of residuals of the trend model, represented by the exponential function

Fig. 13. The graph of the third differences of the trend model's residuals, represented by the exponential function

On the basis of these values a model of autoregression (AR) of the first order was built, the characteristics of which are presented in Table 10.

Table 10

The autoregression model for the third differences of residuals of the commercial debt

Input: DELT3RS4 (new_debt_ukraina.sta)						
Transformations: none						
Model:(1,0,0) MS Residual=46.432						
		Asympt.	Asympt.		Lower	Upper
	Param.	Std.Err.	t(20)	p	95 % Conf	95 % Conf
p(1)	-0.61171	0.215337	-2.84069	0.010104	-1.06089	-0.16252

With the help of the built autoregressive model, predicted values of exogenous shocks which influence the indicators of the commercial public debt of Ukraine have been received (Table 11).

Table 11

The forecast of the third difference values for residuals of the dynamics of the commercial debt (based on the autoregression model) for 2016 – 2018 years

Forecasts; Model:(1,0,0) Seasonal lag: 12				
Input: DELT3RS4				
Start of origin: 1 End of origin: 21				
		Lower	Upper	
	Forecast	90.0000 %	90.0000 %	Std.Err.
22 (2016)	-10.0328	-21.7852	1.71952 6	6.81408 4
23 (2017)	6.137162	-7.63964	19.9139 6	7.98785 4
24 (2018)	-3.75414	-18.2158	10.7074 9	8.38492 3

Thus, on the basis of the conducted analysis of materials of researches on the EU countries and Ukraine, it has been shown that under the modern conditions the non-linear dynamics of the public debt may be one of the causes of unstable development of the economies that are particularly sensitive to manifestations of internal and external crises. Considerable government regulation and interventions in the financial sector were common to many EU countries in

the period of the global crisis of 2008 – 2011 years. The snowball effect that characterizes the growth of public debt which was observed in some of the most troubled countries of the EU (Greece, Ireland, Spain) during the crisis of 2008 – 2011, was accompanied by a rising inflation and the inability to solve the internal financial and economic problems without significant external support from the EU. At the same time, stabilization loans given to these countries by the EU and other international financial institutions, were the only effective measure in the short term, as they shifted the debt burden to the next generations. Similar processes connected with negative phenomena in the social and economic spheres against the background of the global external crisis and internal destabilizing political and economic factors, are observed in Ukraine.

Therefore, it is important in scientific and practical terms to analyze the public debt dynamics and study its impact on the main macroeconomic indicators.

Building a VAR model and conducting an impulse analysis enabled the researchers to show the impact of changes in the government debt per capita on the inflation indicators and the GDP per capita. On the basis of applying autoregression models and moving average there have been obtained the forecasts of the influence of various exogenous shocks on the dynamics of public debt indicators for the period of 2016 – 2018 years.

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Information about the authors

O. Rayevnyeva – Doctor of Sciences in Economics, Professor, Head of Statistics and Economic Forecasting Department of Simon Kuznets Kharkiv National University of Economics (9-A Nauky Ave., Kharkiv, Ukraine, 61166, e-mail: olena.raev@m.hneu.edu.ua).

N. Dubrovina – PhD in Economics, Associate Professor, researcher of Finance Department of the University of Economics in Bratislava (1 Dolnozemska Tsesta St., Bratislava, the Slovak Republic, e-mail: nadija@mail.ru).

Інформація про авторів

Раєвнева Олена Валентинівна – докт. екон. наук, професор, завідувач кафедри статистики та економічного прогнозування Харківського національного економічного університету імені Семена Кузнеця (просп. Науки, 9-А, м. Харків, Україна, 61166, e-mail: olena.raev@m.hneu.edu.ua).

Дубровіна Надія Анатоліївна – канд. екон. наук, доцент, дослідник на кафедрі фінансів Економічного університету Братислави (вул. Дольноземська Цеста 1, м. Братислава, Словачька Республіка, e-mail: nadija@mail.ru).

Информация об авторах

Раевнева Елена Валентиновна – докт. экон. наук, профессор, заведующая кафедрой статистики и экономического прогнозирования Харьковского национального экономического университета имени Семена Кузнеця (просп. Науки, 9-А, г. Харьков, Украина, 61166, e-mail: olena.raev@m.hneu.edu.ua).

Дубровина Надежда Анатольевна – канд. экон. наук, доцент, исследователь кафедры финансов Экономического университета Братиславы (ул. Дольноземска Цеста 1, г. Братислава, Словацкая Республика, e-mail: nadija@mail.ru).

Стаття надійшла до ред.

10.05.2016 р.