Internal public debt and economic growth: a case study of Ukraine

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Internal Public Debt and Economic Growth: a case study of Ukraine

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I. Introduction

The tendency of public debt growth in the remarkable variety of countries has been an important issue in the recent economic debates accelerated by a range of crises overspreading during the last decades. The worldwide study of the public borrowing thematic together with a sluggish renewal of the world economy focuses on factors and after-effects of the growing debt burden. The majority of the research, targeted at different countries and its groups from least developing to highly developed ones, are carried out to measure debt-to-GDP threshold ratio. Taking into account recent progress in foreign public debt substitution by the domestic one in the developing world, the general researchers' interests have changed from external to internal sources of the public debt formation. That is why the challenging area of the paperwork study was the case of Ukrainian developing economy behavior under a growing burden of the internal public debt.

In their influential study, Reinhart and Rogoff (2010) have determined 90% threshold of public debt-to-GDP ratio above which a further growth of advanced economies became moderate. In comparison to the developed world, the threshold ratio in emerging markets was a bit lower, about 60%, which associated with a weak macroeconomic policy and undeveloped economic institutions. The evidence of the lower threshold of the public debt-to-GDP ratio in the developing countries in comparison to the developed ones had a number of conformations. Greenidge, et al. (2012) have proved the value of 55-56% threshold ratio in the Caribbean. In the earlier study, Caner, Grennes, and Koehler-Geib (2010) have come to conclusion by reproducing 64% threshold ratio between public debt and GDP in the emerging market economies.

It should, however, be noted, there is no strong evidence to confirm an absolute negative or positive debt-to-GDP ratio in connection with economic growth. Afonso and Jalles (2011) verified public debt influence on GDP when the ratio was outside the range 30%-90%. The final conclusion was not so strong assuming 10% increase in the ratio outside the range produced less than 1% change of GDP dynamics. Checherita and Rother (2010) have confirmed 90% threshold ratio between public debt and GDP in a long period using the sample of 12 Euro-area countries. However, according to the confidence intervals measuring in the work, the threshold ratio has already started from 70-80% of GDP. Gheorghita

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and Marius Dincă (2015) in the research based on the sample of 10 former Communist countries, the current members of the EU27, estimated the government debt-to-GDP threshold ratio over 1999-2010 opened at 50%. Panizza and Presbitero (2013) concluded a very poor link between positive and negative confirmations in the threshold ratio estimation to be a convincing argument. One of the latter authors, Presbitero (2012), carried out a further research concentrated not only on public debt but on its internal share based on the panel data of low- and middle-income countries. According to the study, the threshold ratio had a tendency to grow after 1990 up to 90% of GDP.

Considering the increasing share of the internal public debt from the end of 20th century in the countries with low income level of development, an active field of the debt study has shifted to developing economies. There is a newly formed tendency of external share substitution by the internal part of the public debt in developing economies, which intensified by a range of crises happened in the last decades. As stated by Bua, Pradelli and Presbitero (2014), the rising internal and reducing external share of the public debt in 1971-2011 became notably clear in non-heavily indebted poor countries. In the very countries, the share of internal public debt has reached 15-40% of the total sum of the government liabilities.

The evidence of internal public debt influence on GDP growth is relatively limited due to poor statistics, especially in the developing countries. Among the possible explanations, there is a weak motivation of international financial institutions to be interested in dynamics of internal public debt in the developing economies, as well as an appropriate transparency of the countries' statistical departments in collecting and publishing the corresponding data (Reinhart & Rogoff, 2009, pp. 13-14).

The new conceptual approach in the research of debt problematic called fiscal space has popularized a unique method for examining debt-to-GDP ratio. The analysis of the fiscal space rule in estimating the public debt limits operated around long-run dynamics and policy implications rather than an examination of the negative debt influence on growth in a short-run period. So, the fiscal space has been an effective guideline instrument for the future policy elaboration based on the influential factors that have to be developed in a longer perspective (Ostry, et al., 2010).

Pescatori, Sandri, and Simon (2014) stepped forward with an interesting statement that implications of debt policy implementations strongly depended on prediction horizon used for data collection. Considering the data introspective, the researchers worked on the periods of 1, 5, 10, and 15 years, and emphasized that the threshold ratio measures should be different among the chosen episodes and interpretations of the results. The prescribed 90% threshold ratio should be a critical point after which a possible slow reduction of GDP became an incentive factor for further acceleration of the debt growth. In preface from a longer view (5, 10, or 15 years), it was a common practice to restore GDP growth after changing a slope of the debt trend from positive to the negative mark. At the same time, it was no matter

how much high the debt was beforehand. So, to carry out the study of the public debt it was important to take into account not only a short-run period but a longer one over five years and above.

Ukraine, as one of developing economy, has entered into recession in 2013-2014 with many problems, including rapid growth of public debt. The public debt-to-GDP ratio has increased dramatically over the last decade from 14.3% in 2005 to 69.3% in 2016, while the internal share has crossed the border of 28.1%. The situation was very crucial to develop quick and efficient measures to slow down a further growth of the public debt. Suspecting the macro stabilization started in 2016, it was important to estimate a public debt-to-GDP threshold ratio as one of the study issues of Ukrainian debt problematic.

II. Theoretical framework

Let's write down the known identity of the central bank's budget constraint (similar to the fiscal budget constraint). According to the ratio, the rise in amount of the internal public debt held by the central bank (**ΔD**), and its revenues transferred to the Treasury (**RCB**) equal the interest paid by the fiscal system to the central bank for past borrowings (**iD**), and the rise in its liabilities represented by the difference in the amount of "high-powered money" – the monetary base (**ΔMB)**:

$$\Delta D + RCB = iD + \Delta MB \qquad (1)$$

In most cases, the central bank revenues and the interest paid by the fiscal system are smaller in volumes to one or more numerical orders than the changes in the monetary base and the public debt. Taking into account the last statement, we may assume that the change in internal public debt obligations to the central bank approximately equals the change in the monetary base. In this case, the coverage of the budget deficit is due to the increase in the internal public debt through the issuance of Government bonds redeemed by the central bank using money emission instrument. The described mechanism is well known in economy and called "quantitative easing" (QE). Under certain conditions, the equation (1) takes the form:

$$\Delta D \simeq \Delta MB \quad (2)$$

Let's go on with the well-known definition of the Quantitative Theory of Money. Assuming a steady rate of money velocity, the given equation turns into a ratio in which the change in volume of the output (**ΔY**) equals the difference between the change in volume of the money supply (**ΔM**) and the change in level of the price (**ΔP**):

$$\Delta Y \simeq \Delta M - \Delta P \qquad (3)$$

According to the well-known theoretical conception the Modern Theory of Money (MTM), after implementing QE policy, the change in volume of the monetary base adjusts upwards the level of the price which associated with a phenomenon 'monetary inflation'. The theory, in particular, regulates that supply of money is mostly determined endogenously, and exogenous factors, such as budget deficit/surplus, allow the Government to establish and maintain inflation targeting. As pointed out by the

adherents of the MTM theory Tymoigne and Wray (2013), the monetary inflation and the price inflation are not the same concepts. In a case of uncontrolled funding, the monetary inflation comes to boost an aggregate demand, which compensated to some extent by the price inflation. Taking into account the above-mentioned remark, we may assume that the change in level of the price (**ΔP**) is mainly due to the 'monetary inflation' issue, which, in turn, is a result of the change in volume of the monetary base (**ΔMB**). Substituting (**ΔP**) in equation (3) by (**ΔMB**) in equation (2), obtain:

$$\Delta Y \simeq \Delta M - \Delta D \Rightarrow \Delta Y = f\left(\frac{\Delta M}{\Delta D}\right) \qquad (4)$$

So, the change of output corresponds to the relation between the change of money supply and the change of internal public debt. If the instrument of money emission is mostly used for public debt monetization, economic growth is slowing down. The possible outcome of the debt monetization is a presence of so-called 'crowding out' effect when a growing demand of the Government for borrowing replaces an expected investment of real sector. If the expansion of the money supply exceeds the rise in government debt to finance the budget deficit, then a certain part of the banking loans can be used to meet investment needs of the real sector. As a result, an augmenting volume of the real sector investment becomes a significant factor in accelerating economic growth.

The relationship between a rate of economic growth and a ratio of change in volume of the money supply to change in volume of the internal public debt tested on the relevant statistics of Ukraine in 2007-2017 (**Fig. 1**). In periods when ΔM2-to-ΔDint ratio exceeded the value of one, the rates of economic growth were positive and higher than the greater was the indicated ratio. At the same time, during the periods, when ΔM2-to-ΔDint ratio was equal or smaller than the value of one, the rate of economic growth slowed down faster than the indicated proportion was less. The correlation between the real GDP and the depicted ratio was strong enough (0.72) as to be one of the factors of growth in Ukraine.

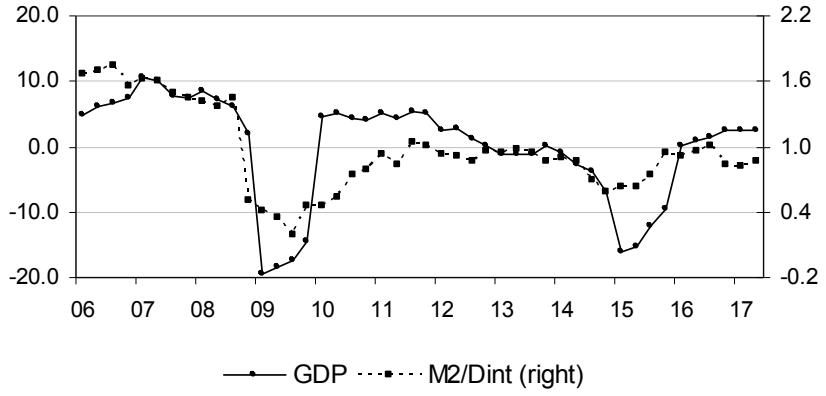

Figure 1. The comparative dynamics of GDP and the ratio of broad money (M2) to internal public debt (Dint), Q1 2006-Q2 2017 (*Y-o-Y, 2007=100*)

Source: the State Statistics Service of Ukraine, the National Bank of Ukraine, and the State Treasury of Ukraine.

The components of the described relationship are key indicators of development of the two sectors of economy: fiscal **(ΔDint**) and monetary (**ΔM2**). The results of the presented theoretical framework used in developing scenario modeling instrument based on fiscal-monetary interaction.

III. Model

The analytical framework of public debt impact on GDP dynamics in the most cases follows linear and non-linear complex solutions built using time-series econometric techniques like ordinary least squares (OLS) or instrumental variables. The general approach of the public debt study usually relates to a panel data processing because of a multivariate research facility directed to an array of countries or its groups. Because of several crises taken place in the world during the last decades, economists have forced to impose special restrictions on economic development under pressure of internal and external shocks. While analyzing behavior specifics concerning the economy in crisis in the context of elaborating an appropriate modeling instrument, there is a need to carry out the public debt study as for an array of countries as well for the particular economy.

Considering the aforementioned remarks, an attempt was made to investigate a relation between dynamics of public debt and GDP in Ukraine over the last decade. The general purpose of the study was to determine internal public debt-to-GDP threshold ratio using a scenario modeling instrument. Taking into account a growing public debt burden on economic development in Ukraine, we elaborated an econometric macro model operated through fiscal-monetary interaction.

While constructing the model, we took into account a few basic principles of macro modeling. The principles were suggested by Japanese scientist Takeshita (2003) who measured short-term economic impact paths of fiscal policy. The Japanese macro-econometric model consisted of eight blocks corresponded to 97 econometrically estimated behavioral and definitional equations. The independent blocks were solved simultaneously. Among important characteristics of the model, there were consistencies with economic theory, special features of Japanese economy development, easy operation, and strong econometric techniques, including several tests, especially CUSUM one. The fiscal, monetary and real side factors employed a central place in the model.

A similar modeling tool built for the case of economy of Ukraine was not so complicated, and, in addition to national specifics, took into consideration an excessive public debt impact on macro dynamics that examined in the theoretical framework of this article. The general design of the modeling tool was to disclose a fiscal-monetary interaction through interconnections of macro indicators. The model comprised three general blocks: real, public, and monetary sectors. The input data of the model were Domestic Government Bonds (DGB) and a quantity of active population. The output data was GDP. The Public Sector block was represented by three components: Government Expenditure, Government Revenue, and Government Deficit. The real sector block was built using production function approach and comprised Public Investments and Wage Fund. The monetary sector block was not outlined separately, and included among other elements Exchange Rate, M2, and CPI. The other elements disclosed relations between the general blocks (**Fig. 2**).

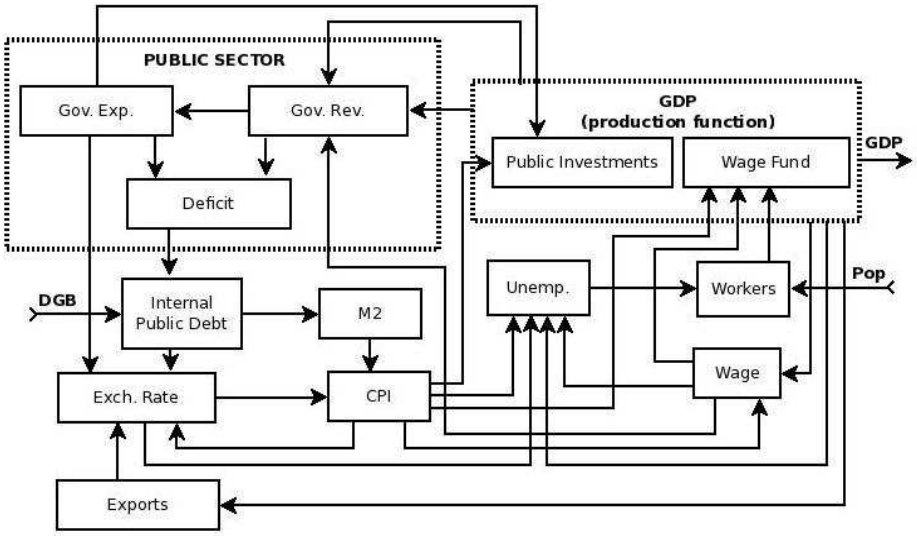

Figure 2. The model of fiscal-monetary interaction

Source: the product of author's research.

The public debt component was used wherever possible in the behavioral equations grouped in the recursive system of 10 regressions and two identities based on quarterly time-series data. The econometric instrument used to build multivariate nonlinear regressions was OLS. The simplified form of the system is given below:

$$
\begin{aligned}
&\mathrm{GDP}=\mathrm{f}(\mathrm{InvG},\mathrm{WageFund})\\
&\mathrm{InvG}=\mathrm{f}(\mathrm{GExp},\mathrm{CPI})\\
&\mathrm{Wage1}=\mathrm{f}(\mathrm{GDP},\mathrm{M2},\mathrm{CPI})\\
&\mathrm{GExp}=\mathrm{f}(\mathrm{GRev},\mathrm{GExp})\\
&\mathrm{CPI}=\mathrm{f}(\mathrm{M2},\mathrm{Exch})\\
&\mathrm{Unem}=\mathrm{f}(\mathrm{CPI},\mathrm{Exch},\mathrm{WageFund},\mathrm{GDP})\\
&\mathrm{GRev}=\mathrm{f}(\mathrm{GDP},\mathrm{Wage1},\mathrm{GRev},\mathrm{GDP})\\
&\mathrm{Exch}=\mathrm{f}(\mathrm{X},\mathrm{GExp},DGB,\mathrm{CPI})\\
&\mathrm{X}=\mathrm{f}(\mathrm{GDP})\\
&M2=f(DGB)\\
&\mathrm{WageFund}_r=\mathrm{Wage1}_r\times\mathrm{Worker}\\
&\mathrm{Worker}=\mathrm{Pop}\times(1-\mathrm{Unem}/100)
\end{aligned}
\qquad (5)
$$

Where: GDP is gross domestic product, InvG - public investment, Wage1 - wage per employed worker, Pop - quantity of active population, Worker - quantity of employed worker, WageFund - total sum of payroll, GExp - Government expenditures, CPI - consumer price index, Unem - unemployment rate, GRev - Government revenues, M2 - broad money, Exch - exchange rate, DGB - DGB in circulation, X - export of goods and services.

The GDP equation took a form of modified Cobb-Douglass production function. The main point of the modification was to use the public investment as a capital factor. The latter was right because the dynamics of the total sum of investment and the public investment were similar to a very large extent in Ukraine. The volatility predominance of the State and the Local budgets funds were on average two and a half times as fast over the other components of the investment structure by the sources of financing in 2006-2017.

The average wage per worker, as part of the total sum of payroll in the equation of production function, depended on lagged GDP, broad money (M2) and CPI. The other part of the total sum of payroll, the quantity of employed workers, depended on the quantity of active population and the unemployment rate. In turn, the unemployment rate was a function of lagged CPI, lagged exchange rate, and lagged total sum of payroll in ratio to GDP.

The highest volatility component of the Government expenditure structure by economic classification in Ukraine was Government investment with a share about 10%. The value of the given share changed on average two times as fast in 2006-2017 compared to the value of the share of government consumption and transfer payments. Therefore, the public investment was represented by a function of the Government expenditure.

Another general block of the model included the State budget of Ukraine. The Government expenditure of the State budget depended on the Government revenue, while the Government revenue was a function of GDP, lagged average wage per employed worker, and lagged Government revenue in relation to GDP.

The relationship between public and real sectors was reproduced using funds turnover through monetary and foreign exchange markets. The budget deficit was covered at the expenses of seigniorage as a matter of monetary policy implementation in a view of money supply adjusting. In accordance with model design, the input data DGB was a debt instrument of budget deficit financing, and an important factor of fiscal-monetary interaction. The dynamics of DGB finally determines the dynamics of CPI, and exchange rate. The exchange rate was a function of lagged net export of goods and services, lagged Government expenditure, DGB, and CPI. In turn, the CPI depended on lagged broad money (M2), and lagged exchange rate.

IV. Data and Methodology

The data retrospective of the model covered a period from Q1 2006 to Q2 2017, but the working timeline is concentrated between the two consecutive recessions taken place in 2008-2009 and 2014-2015. The retrospective 2008-2013 was very remarkable because it was a period of returning from economic slump to stabilization and growth, and, at the same time, when public debt growth was the fastest (**Fig. 3**). Besides, the duration of the retrospective was long enough to meet an important requirement to use the period lasted no less than five years as mentioned in the research developed by Pescatori, Sandri and Simon (2014).

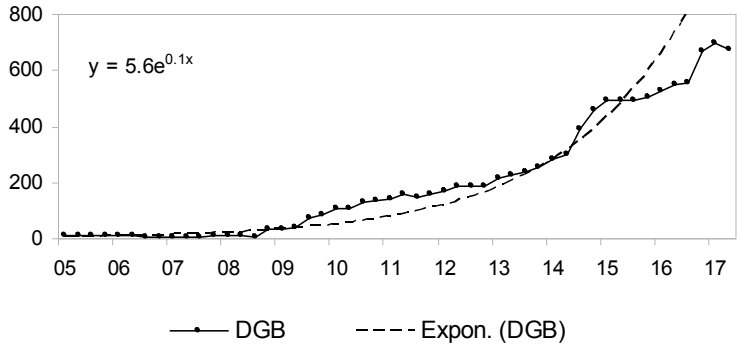

Figure 3. The dynamics of DGB,
Q1 2005-Q2 2017 (bln. UAN)

Source: the National Bank of Ukraine.

The measurement of variables in the model was natural logarithm Q-o-Q to maintain a high level of responsibility upon input data change. While selecting the variables in OLS regressions, in addition to standard econometric verification a special care was taken to the normality of residual distribution and CUSUM test results. The first parameter was chosen to ensure a valid combination of factors, and the second one was responsible for a total level of mutual errors in the modeling results. Also, we kept attention to the distribution of t-statistics to preserve a minimum value of scattering for the chosen regression.

There was an event of significant relationship between M2 and DGB in circulation in Ukraine. The correlation between the indicators in 2005-2017 was strong enough (R^2=0.83) to be an economic event (**Fig. 4**). The period of maximum correlation in 2008-2013 corresponded with the chosen timeline of the scenario modeling. The economic background of the event had much to do with fiscal-monetary interaction. Among the four possible forms of the interaction, it was a case of active fiscal and passive monetary policy in Ukraine.

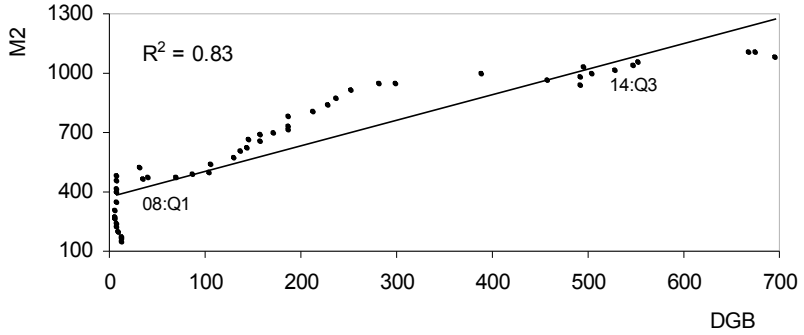

Figure 4. The correlation between DGB and M2,
Q1 2005-Q2 2017 (*bln. UAN*)

Source: the National Bank of Ukraine.

One of the common instruments of internal public debt monetization in Ukraine was DGB. Among the potential buyers of DGB were the National Bank of Ukraine (NBU) and several commercial banks with a domination of the former (the amount of DGB in the portfolio of the National Bank of Ukraine has surpassed an amount of monetary base in 2015). The volume of the debt monetization was large enough to motivate a corresponding volatility of the money supply. So, from 2008 and up to the third quarter of 2014 there was a strong correlation between the DGB and the broad money (M2) in Ukraine (see **Fig. 4**).

The algorithm for estimating internal public debt-to-GDP threshold ratio consisted in applying scenario modeling instrument to reproduce real GDP dynamics compared to its linear trend. The DGB variable, as a major share of internal public debt structure (about 98%), was an input data of the model and, at the same time, a regulation parameter. We were able to select an appropriate exponential trend of DGB in circulation over 2005-2014 (see **Fig. 3**). The intercept of the trend was modified step by step to provide a diversity of the regular scenarios. Following the different scenarios, we obtain the output data of the model, real GDP, which changed in the appropriate way. While establishing several scenarios, the linear trend slope of real GDP dynamics measured in Y-o-Y was changing its value from positive mark to the negative. The very critical point corresponded with the internal public debt-to-GDP threshold ratio. The threshold was measured as an average value of the ratio between the level of DGB in circulation and GDP over 2008-2013.

The distribution of internal and external share of the public debt in Ukraine was somewhat similar in 2008-2014. So, with an acceptable level of error, it was possible to estimate a volume of the public debt using only one of the two components, in this case, the internal part. The last remark was important because of relatively low priority in researchers' community to study internal public debt along with the indicator of the total sum of the public borrowings. So, for the case of Ukraine, it was possible to compare results of threshold ratio estimation with a majority of the similar study performed for a considerable number of countries.

V. Results

The elaborated macro model of fiscal-monetary interaction was used to estimate real GDP dynamics in Ukraine over 11 year's retrospective from Q1 2006 to Q2 2017. The MAPE error of the modeling results over the given period didn't exceed 7% and corresponded with a good accuracy (**Fig. 5**). Thus, the methodically developed instrument was appropriate for the purpose of scenario modeling.

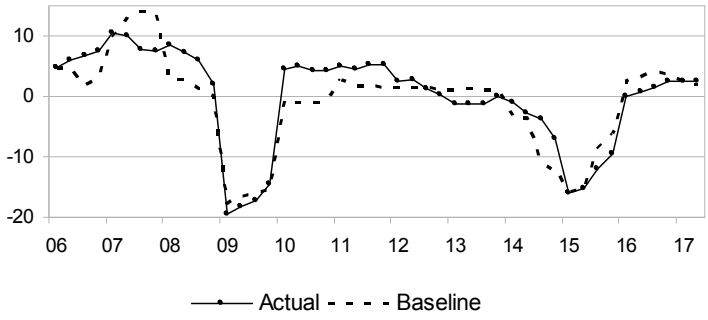

Figure 5. The dynamics of GDP,
Q1 2006-Q2 2017 (*Y-o-Y, 2007=100*)

Source: the State Statistics Service of Ukraine and the modeling results.

The key indicator to estimate internal public debt-to-GDP threshold ratio was the slope of the linear trend of real GDP measured in year cumulative changes and obtained through modeling results. The regulation parameter to perform a diversity of scenarios was the intercept variable of the DGB exponential trend. The added values of the intercept parameter corresponded with the modeling scenarios in compliance with a range of the average ratios between the amount of DGB in circulation and GDP over the period 2008-2013. There were seven scenarios of the gradual addition of the intercept value coming up to seven times higher. As a result of the multiple computation procedures, the corresponding change of the average ratio between the amount of DGB in circulation and GDP diversified from 15% in the 1st or base scenario to 50% in the 7th one (**Tab. 1**).

Table 1

The scenario verification of the threshold ratio, (*Q1 2008-Q4 2013*)

Scenario	DGB/GDP, Av., %, 2007=100	Slope of Linear (GDP)
Base	13	0.37
1	28	0.20
2	33	0.12
3	38	0.05
4	**40**	**0.00**
5	42	-0.02
6	46	-0.08
7	50	-0.14

Source: The scenario modeling results.

According to the scenario results, the DGB-to-GDP threshold ratio was 40%. Taking into account the share of DGB in the structure of the internal public debt was about 98% in Ukraine, we had the right to extend the modeling results and fixed the internal public debt-to-GDP threshold ratio to the same level of 40% (see **Tab. 1**). As mentioned in the section of methodology and data of this paper, the value of the internal share of the public debt in Ukraine was roughly similar compared to the external part in 2008-2013. So, with an acceptable level of accuracy, we were able to assume that the public debt-to-GDP threshold ratio in Ukraine was about 80%.

The study results of the threshold ratio estimation for the case of Ukraine corresponded with the similar conclusion obtained for developing economies and varied from 44% to 90%. The actual data of the public debt-to-GDP ratio dated to the end of 2016 was 69.3%, while the internal share crossed the border of 28.1%. Considering the IMF Country Report No. 17/83-2017 about Ukraine midterm perspective following the Extended Fund Facility program, the expected level of the public debt-to-GDP ratio after a gradual growth will drop below the point 70.0% by the end of 2021. Although the public debt-to-GDP ratio remained below the estimated threshold ratio as of the second quarter of 2017, the space degree was minimal, and the indicator was going to run over the critical level. Considering sluggish economic recovery following the last recession took place in 2014-2015, Ukraine would face the challenge of reopening the agenda of growing debt burden in a near future.

VI. Conclusion

The case of growing public debt in a considerable number of countries has taken a remarkable place in the current thematic. The range of crises happened in the last decades has been a booster of the debt growth in the world economy. One of the ways to study the problem is to measure debt-to-GDP threshold ratio. In such a context, the different methods used to estimate the given ratio have been in a

focus of the recent economic debates. In a majority of papers dedicated to the debt study, it is common to use the same method to evaluate the threshold ratio directed to an array of countries. However, there are some limitations of using the mentioned approach due to behavior specifics for the economy in crises and thereafter. That is why there is a need to carry out the public debt study for the particular economy as well.

The last publications dedicated to the estimation of public debt-to-GDP threshold ratio have grouped around a level of 90% for developed countries and a lower mark opened at 50% for developing economies. The substitution of an external share of the public debt by its internal part in the developing economies has intensified during the latest crises. Therefore, the threshold ratio of the internal public debt-to-GDP in the developing economies has gone beyond the similar indicator for its external component. Taking into account the last statement, the efforts to advance the public debt study have to focus on exploring the impact factors of the internal borrowings. At the same time, the internal public debt is not a focus of the debt thematic. One of the possible explanations to the mentioned remark is an absence of appropriate transparency in collecting and publishing corresponding data, especially in the developing countries.

Taking into account a growing burden of public debt in Ukraine, we elaborated the econometric macro model operated through fiscal-monetary interaction. Besides national specifics, the model incorporated an excessive public debt impact on GDP dynamics. The model consisted of 10 behavioral equations and two identities, which grouped in a system of recursive regressions based on quarterly time-series data. The working paper suggested an algorithm for estimating internal public debt-to-GDP threshold ratio by applying a scenario modeling tool.

According to the modeling results, the threshold ratio proved to be 40% of GDP, while the similar result for the total amount of public borrowings was about twice as high. The obtained threshold ratio corresponded with conclusion published in the IMF Country Report No. 17/83-2017 about Ukraine midterm perspective following the Extended Fund Facility program. According to the report, the expected level of the public debt-to-GDP ratio after a gradual growth would drop below the point 70.0% by the end of 2021. Given the last statement, the public debt-to-GDP ratio in Ukraine remained below the estimated threshold ratio as of the second quarter of 2017, but a space degree was small and going to collapse soon. Taking into account sluggish economic recovery following the last recession took place in 2014-2015, Ukraine would face the challenge of reopening the agenda of growing debt burden in a near future.

In the further work, care should be taken to external public debt. The external share of the public debt in Ukraine outran its internal part in 2015. Taking into account the given fact, it is necessary to develop the current study in the way of incorporating impact factors of the external public debt dynamics.

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Appendix 1. The model specification

Variable	Description	Source
GDP	Gross domestic product	State Statistics Service of Ukraine
InvP	Public investment	State Statistics Service of Ukraine
Wage1	Wage per employed worker	State Statistics Service of Ukraine
Pop	Quantity of active population	State Statistics Service of Ukraine
Worker	Quantity of employed worker	State Statistics Service of Ukraine
WageFund	Total sum of payroll	
GExp	Government expenditures	Ministry of Finance of Ukraine
CPI	Consumer price index, 2004:Q4 = 100	State Statistics Service of Ukraine
Unem	Unemployment rate	State Statistics Service of Ukraine
GRev	Government revenues	Ministry of Finance of Ukraine
M2	Broad money	National Bank of Ukraine
Exch	Exchange rate, UAN/USD	National Bank of Ukraine
Dq	Seasonal dummy variable {1,2,3,4}	
DGB	DGB in circulation	National Bank of Ukraine
X	Export of goods and services	State Statistics Service of Ukraine

Appendix 2 The main econometric characteristics of the multivariate system of equations, OLS, Q2 2006-Q2 2017, natural logarithm Q-o-Q

VARIABLES	GDP_r	$InvG_r$	$Wage1_r$	$GExp_r$	CPI	Unem	$GRev_r$	Exch	X_r
$InvG_r(-4)$	[7.14]								
$WageFund_r$	[3.90]								
$GExp_r(-1)$		[4.48]							
$CPI_{(2007=100)}$		[-3.08]	[-7.67]						
Dq		[18.2]							
$GDP_r(-4)$			[3.80]						[11.52]
M2			[5.80]						
$GRev_r$				[6.75]					
$GExp_r(-4)$				[4.43]					
M2(-1)					[4.39]				
Exch(-1)					[5.16]				
Dq(-2)					[2.48]				
CPI(-2)					[2.95]				
$(WageFund_r(-2)/$ $GDP_r(-3))$						[7.17]			
$CPI_{(2007=100)}(-1)$						[-6.02]			
Exch(-1)						[4.80]			
GDP_r							[7.32]		
$Wage1_r(-2)$							[4.10]		
$GRev_r(-1)/$ $GDP_r(-1)$							[-5.62]		
$X_r(-1)$								[-4.13]	
$GExp_r(-1)$								[4.09]	
DGB_r								[3.95]	
CPI								[4.97]	
C								[-1.44]	
R^2	0.93	0.98	0.91	0.83	0.67	0.75	0.71	0.54	0.75
F-statistics	273.1	586.8	138.3	108.6	21.4	43.5	36.4	12.5	132.8
DW	1.93	2.05	1.59	2.40	1.75	2.10	2.30	1.83	2.03

Note: r - real values (2007=100), lags in brackets, robust t-statistics in square brackets.