The current issue and full text archive of this journal is available on Emerald Insight at:
https://www.emerald.com/insight/0144-3585.htm



# Imperatives of functioning of the financial market of Ukraine in the global space of debt loading

Natalia V. Trusova and Inna Ye. Yakusheva
*Dmytro Motornyi Tavria State Agrotechnological University, Melitopol, Ukraine, and*
Yuliia M. Zavoloka, Alina H. Yefremenko, Yuliia A. Malashenko and Maryna V. Sidnenko
*Kremenchuk Institute of Alfred Nobel University, Kremenchuk, Ukraine*

Received 23 April 2020
Revised 21 September 2020
10 November 2020
Accepted 10 November 2020

## Abstract

**Purpose** – The article deals with the imperatives of functioning of the financial market of Ukraine in the global space of debt loading.

**Design/methodology/approach** – Within the Laffer debt curve model, the dependence of gross domestic product (GDP) change on the level of debt of the financial system for countries that form the economic core in the global financial space and well control the level of the indicator, as well as new member states that have a different level of secure debt loading and affect the portion of the financial market that forms a portfolio of securities to cover the cost of nonperforming government securities is mentioned.

**Findings** – It has been shown that stock indices, as constituent indicators of changes in the price environment of a certain group of securities in time space, allow to estimate the general direction of the market movement even when prices within the index basket change in different directions.

**Originality/value** – The dynamics of changing the debt loading of the financial system of Ukraine in the current, medium-term perspective is analyzed. The amount of the fixed and floating rate debt of the government internal securities is determined to ensure the diversification of interest rate risk. Using the parameters of the model of approximation functions of dimensionless quantities, the corridor of a safe level of general government debt in the country was determined.

**Keywords** Financial market, Stock indices, Public debt, Financial instruments, Government securities

**Paper type** Research paper

## 1. Introduction

In times of crisis, European Union (EU) member states demonstrate their willingness to support financial institutions – banks, insurance and investment companies that are in the process of bankruptcy – by infusing budgetary resources. In 1988, the Basel Accord was announced to counter bank failures and address the shortcomings of a simple capital-to-asset ratio. The main components of the agreement, their interrelations and directions of specific steps that banks and regulators can take to implement the main provisions are included in the review (Basel Committee on Banking Supervision, 1988). The transition of the banking system to reporting in accordance with International Financial Reporting Standards (IFRS) allows to create a unified financial and operational system. This system will not only improve the transparency of financial reporting but will also allow linking with Pillar III of the Basel Capital Accord. Figure 1 shows this system, which is aimed at improving the performance of banks. The document assumes two main innovations. Firstly, in the analysis of capital adequacy, it is proposed to apply a variety of complex methods for assessing the riskiness of assets (the first "pillar"). Secondly, much attention is paid to market discipline (in other words, information disclosure) and the supervision process itself (the second and third "pillars"). Theoretical studies, for example, indicate that specific regulatory strategies that incorporate

JEL Classification — D53, E42, E44, E51, H63

Journal of Economic Studies

0144-3585
DOI 10.1108/JES-04-2020-0187

all three dimensions can improve the effectiveness of banking regulation (Basel Committee, 2010).

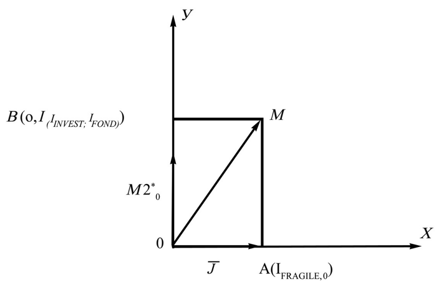
A considerable part of research studies of scientists and practitioners was devoted to the financial market, in particular the works by F. Allen and D. Gale (Allen and Gale, 1997), M. Bijlsma and G. Zwart (Bijlsma and Zwart, 2013), Morselli (2016), J., P. Cooley, R. Roenfeldt, I. Chew (Cooley *et al.*, 1975), Daft (1983), P. Hartmann, F. Heider, E. Papaioannou, Ferguson (2008), M. O'Hara and M. Ye (O'Hara and Ye, 2011).

The search for the optimal development of the macroeconomic structure of national financial systems and the role of stock markets in their architecture was carried out by scientists such as Bayraktar (2014), Carson (2011) and Omarova (2010). The assessment of the critical condition of the financial market is investigated in the works of the following scientists: S. Ardagna and F. Caselli (Ardagna and Caselli, 2014), Grabowski and Stawasz (2017), Holmes (1998), Pengjie and Qi (2013), G. Refet, B. Sack and J. Wright (Refet *et al.*, 2007). In these articles, the authors found basic principles due to which they managed to develop measures to harmonize the functions of financial markets in developing countries in the structure of the global space. Much attention is paid to the study of government-guaranteed debt in the context of national-level financial policies and public finances – S. Londar (2013), Oliinyk and Sidelnikova (2011), the system of debt risk indicators and the thresholds of debt stability – Danyliuk (2013), Londar (2015), Serhiienko (2014), Vlasiuk and Shemaieva (2016), H. Ferreira de Mendonça and M. Pereira Duarte Nunes (Ferreira de Mendonça and Pereira Duarte Nunes, 2011), Abubakar and Mamman (2020), Apergis and Apergis (2019), DiPeitro and Anoruo (2012). The aforementioned researchers agree that ensuring economic growth and an adequate level of social guarantees in the country may depend on the implementation of measures to alleviate the burden of public debt.

Research on the development of methodology and methods for quantitative calculation of systemic relationships between factor, commodity and financial markets remains relevant, especially when it is necessary to build appropriate economic and mathematical models of world stock markets. Little attention has been paid to the interconnections between the stock market segments, their dependence, in particular, on geopolitical and security factors. The priority of our study is to substantiate scenarios for the development of financial market imperatives to mitigate the asymmetry of debt loading, taking into account the target competitive priorities of the global financial space which are conditioned by the parameters of the universal model of financial instruments yield, the structure of the stock segment and the public debt management elements.

## 2. Materials and methods

The theoretical and methodological approach of identifying the relationship between the financial market and the debt loading of the financial system is the so-called "Laffer Debt Curve" (Laffer, 1979), which allows to estimate the level of relative increase in borrowing to gross domestic product (GDP) growth. The increasing public debt and increasing debt loading




$$\overline{OM} = \overline{INDEX} = \overline{OA} + \overline{OB} = I_{FRAGILE}\ \vec{i} + I(I_{INVEST}; I_{FOND})$$

**Figure 1.**
A vector in the Cartesian coordinate system

increase the risks of the financial system. Lenders in the financial markets are responding to this by raising borrowing rates, which causes public debt service costs to increase as GDP rises. This leads to the formation of a so-called debt overhang, that is to say, when the cost of attracting additional financial resources for the borrowing country increases substantially compared to the pace of its economic development. Further borrowing leads to the unwinding of the debt spiral, which forces the construction of the debt pyramid (International Monetary Fund, 2016).

International Monetary Fund (IMF) experts estimate the financial system's debt loading model ($b_t$) as a long-term empirical relationship. At the same time, measures for attracting, accounting, servicing and repayment of public debt should be coordinated, which in time coordinate changes in real GDP growth with inflation and budget growth rates (International Monetary Fund, 2019) (Eq. 1):

$$b_t = \frac{1 + i_t}{(1 + \pi_t) \cdot (1 + g_t)} \cdot b_{t-1} + d_t + e_t, \tag{1}$$

where $b_t$ is the level of debt loading of the financial system to GDP, $i_t$ is the interest rate at which the debt is paid, $\pi_t$ is inflation rate, $g_t$ is real GDP growth rate, $d_t$ denotes the growth rate of the primary GDP deficit and $e_t$ is an additional random variable that takes into account the estimated financial corrections of the primary deficit.

Within the all-European approach ("fiscal consolidation" policy), a number of "new generation fiscal rules" (European Commission, 2020) have been developed, implemented according to target indicators (structural deficit, budget expenditures and debt loading of the financial system) and their calculation algorithm is introduced at the legislative level. Within the Laffer debt curve model, the dependence of GDP change on the level of debt of the financial system for countries that form an economic core in the global financial space and well control the level of the indicator is mentioned. The level of critical debt loading of a country-specific financial system, when a change in the situation of government securities in a financial market above in which the "debt overhang" effect occurs, is considered as a point of zero economic development that occurs when the fixed income within the framework of public debt refinancing depends on the value of the GDP indicator and the debt loading of the financial system. The curve is represented by the quadratic equation (Eq. 2):

$$y = ax^2 + bx + c \tag{2}$$

the maximum of a curve expressed by a quadratic function can be calculated with the use of the following equation (Eq. 3) (Levine, 2005):

$$x_{\max} = -\frac{b}{2a} \tag{3}$$

The methodology of the new world economic order seeks to make effective use of the spatial localization of the financial market (including geographic, demographic, transport, resource, monetary, economic and political activities) and is based on the formation of a new level of strategic interaction of national economies and formation within the world farms of internationalized reproductive nuclei (cycles) that become wandering. Moving cross-border financial systems continues to be an economic environment that mediates the functioning of mobile, internationalized reproduction cycles (nuclei) (International Organization of Securities Commissions, 2011).

Thus, according to the intermediary direction, the stock segment of the financial market provides placement of financial instruments and their rhythmic transformation into real financial flows in the country. At the same time, the capabilities of the stock segment allow the temporary transformation of financial instruments that take into account the risk component, thus reducing the conflict of interest between donor and borrowing countries (Trusova *et al.*, 2017). The functional property of the stock segment details the intermediary direction of its operation under the following conditions: providing ways to move financial instruments across borders of states and ways to manage financial risks in the settlement process and facilitating the trading of securities and coordination of price asymmetry in the securities market, thus preventing the reduction of the share of the investment portfolio in the financial potential of the state and the level of critical debt loading of the country's financial system in the global space. In the meantime, the intermediary function of the banking sector in the structure of the financial market facilitates the movement of financial instruments in time and space in order to diversify the market and mobilize public debt management measures (Trusova *et al.*, 2018).

According to the axiom of classical economic theory, overburdening the money market of any country with money supply in the macro system provokes inflation. Mega regulators of the international financial market are the IMF and the World Bank. In addition, the compression of money supply leads to the filling of money circulation channels with financial surrogates, instead of full, liquid money, which significantly impair its quality (Allen and Gale, 1997). The study of the growth $\Delta M2$ of the monetary aggregate $M2$ will be carried out under the condition of transition from absolute values to dimensionless ones. Therefore, it is suggested to consider a monetization factor equal to (Eq. 4) (Schmidt and Hryckiewicz, 2006):

$$M2^{*} = M2/_{GDP}, \tag{4}$$

The monetization coefficient shows the supply of GDP with money (in this case), which corresponds to the monetary aggregate, which varies in the interval $|0.5;\ \ 1|$ (Eq. 5) (Schmidt and Hryckiewicz, 2006). We consider the ratio of general government debt to GDP (Laffer, 1979; Levine, 2005):

$$DB^{*} = DB/_{GDP}, \tag{5}$$

which makes it possible to compare the total national debt of a country with its economic potential, although this indicator cannot be considered as the only factor that determines a country's level of financial risk. We consider that the limit value of the monetary aggregate function $M2^{*}(DB^{*})$ for the increase of time $\Delta t$ can be defined as a derivative of the function, provided that its continuity is in the form (Laffer, 1979; Levine, 2005) (Eq. 6):

$$\lim_{\Delta t \to 0} \frac{\Delta M2^{*}}{\Delta DB^{*}} = M2^{*''}(x), \tag{6}$$

Let us draw up a differential equation describing the economic process of the rate of relative changes in the monetary aggregate in relation to the general government debt (Eq. 7) (Laffer, 1979; Levine, 2005):

$$\frac{\Delta M2^{*''}(DB)}{M2^{*}(DB^{*})} = INDEX\left(1 - \frac{M2^{*}(DB^{*})}{M2^{*}_{\lim}}\right), \tag{7}$$

We introduce the initial conditions, which means that the monetary aggregate is present in the absence of public debt (Eq. 8) (Laffer, 1979; Levine, 2005):

$$M2^{*}(0) = M2^{*}_{0}, \tag{8}$$

where $M2^{*}_{\lim}$ is the maximum possible value of the monetary aggregate $M2$ of the country and $INDEX$ is a corrective index of the direct proportionality of the country's average monetary aggregate $M2$ and the potential value of the monetary aggregate that the state can acquire. At the same time, the stock segment is distributed among the states as a financial source for the needs of the real sector of economy, with the participation of the banking sector (Allen and Gale, 2001; Hartmann *et al.*, 2003). We consider a vector of the correction index with coordinates (Eq. 9) (Laffer, 1979; Levine, 2005):

$$\overline{INDEX} = \left(I_{FRAGILE}; I_{(I_{INVEST})}; I_{(INVEST)}; I_{FOND}\right), \tag{9}$$

where $I_{FRAGILE}$ is an index that characterizes financial risks and is a regulator of the state's sound financial security strategy and $I_{(I_{INVEST};I_{FOND})}$ are the average index of the investment attractiveness ($I_{INVEST}$) and stock indices ($I_{FOND}$) of the country under study (Figure 1). The value of the vector of the correction index is calculated using Eq. 10 (Laffer, 1979; Levine, 2005):

$$\overline{INDEX} = \sqrt{(I_{FRAGILE})^2 + I^2_{(I_{INVEST};I_{FOND})}} = \sqrt{(I_{FRAGILE})^2 + \left(\sqrt{I_{INVEST} \times I_{FOND}}\right)^2}$$

$$= \sqrt{(I_{FRAGILE})^2 + I_{INVEST} \times I_{FOND}}, \tag{10}$$

Geometric interpretation of the function of the monetary aggregate on the national debt, given by equation (8) obtained as a solution of the first-order differential equation (11) with initial conditions, makes it possible to analyze this functional dependence for developing countries to determine the corridor of a secure level of general government debt using the theory of elasticity of economic functions (Eq. 11; Figure 2):

$$M2^* = \frac{M2^*_{\lim}}{1 + \frac{M2^*_{\lim} - M2^*_0}{M2^*_0 \times M2^*_{\lim}} \times e^{-INDEX \times DB^*}} \tag{11}$$

We find the elasticity $E_{DB^*}(M2^*)$ of the monetary aggregate $M2^*(DB^*)$ function, where $\Delta M2$ is growth of the monetary aggregate ($M2$) (Eq. 12) (Laffer, 1979; Levine, 2005):

$$\frac{M2^*_{\lim} - M2^*_0}{M2^*_0 \times M2^*_{\lim}} \times (INDEX \times M2^* - 1) \geq e^{INDEX \times M2^*}, \tag{12}$$

The left part of the inequality (12) is a straight line and the right part is an exponential function. Therefore, inequality (12) can be calculated only numerically, providing the conditions for determining the limit of a safe level of the general national debt of the country (Figure 3).

We propose a comprehensive methodological approach to determine the competitive priorities of assessing the capabilities of a stock segment in its redistribution in the financial market, with the establishment of the optimal market value (market portfolio) of securities and reducing the level of risk, which is achieved by increasing the degree of transparency of flows movement in the global financial space. Forming the yield of financial instruments

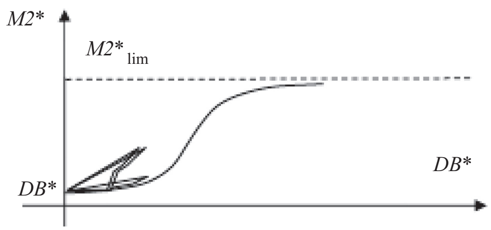



**Figure 2.**
The function given by equation (9)

(securities) with the distribution of their value among investors in the global space of the world countries implies the construction of a universal model of expected return under the influence of economic factors: financial–credit system, monetary market, inflation and so on. To build a universal model of the expected yield of government securities, which allows to fully taking into account the time factor of profitability, the mathematical transformation of the rate of increase of the discount rate of cash income was used (Eq. 13) (Fisher, 1930):

$$1 + RR = \frac{I + P_1}{P_0}; \Rightarrow P_0 \times (1 + RR) = I + P_1; \Rightarrow P_0 = \frac{I + P_1}{1 + RR}, \tag{13}$$

We start the transformation of the expression with the numerator taking into account that there may be two or more incomes for the benefit of the investor and they all occur at regular intervals. If the first income is ($CF_1$), and for the period ($n$), separating the first and second incomes, the rate of income is ($k$), then at the time of occurrences of the second element of the cash flow the first one will be appreciated at $CF_1 \times (1 + k)$. After two periods $n$ (that is, at the time of the occurrence of the third income), its value at the end of the first period is increased by the income for the second period, i.e. (Eq. 14)

$$CF_1 \times (1 + k) \times (1 + k) = CF_1 \times (1 + k)^2 \tag{14}$$

Conversely, any subsequent income can be estimated at the time of the occurrence of the previous one, for example, the value ($CF_2$) at the time of the first income will be $CF_2/(1 + k)$. This means that the investor waived the additional income at the time of receipt ($CF_1$) for the sake of receipt ($CF_2$) after one period ($n$). Similarly, ($CF_3$) at the time occurrences of the second income, the value of the government securities will be estimated at $CF_3/(1 + k)$ and the first at $CF_3/(1 + k)^2$. When calculating the amount of cash inflow into the future value, it is increased with the use of income $k$. If actual cash flow and maturity periods are within one year ($n$), then a simple increase is made and for more periods, it will be compounding (capitalization of the sum of interest at the end of each period). At the end of the first year, the calculation of the total present value of all cash inflows on government securities will be as follows (Eq. 15) (Fisher, 1930):

$$RV = CF_1 \times (1 + k)^{\frac{365}{n}} + CF_2 \times (1 + k)^{\frac{365}{n} - 2} + \cdots + CF_t \times (1 + k)^{\frac{365}{n} - t} = \sum_{i=1}^{t} CF_i \times (1 + k)^{\frac{365}{n} - i}, \tag{15}$$

If cash flow from transactions with government securities arises during the first year ($n \leq 365$), then its inclusion in the total present cash flow implies an increase, if after that, it implies discounting. However, both increasing and discounting are carried out using the

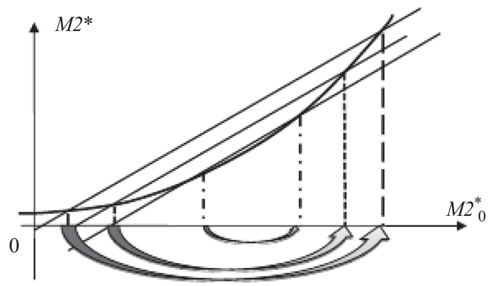



**Figure 3.**
Determination of the limits of the secure level of public debt

income rate $k$ (for the period $n$). Accordingly, all the conversions performed are focused on using the annual rate of return ($r$), so it is necessary to establish the relationship between the indicators. The projected rate of growth of securities capital over the period ($n$) is determined by the expression $(1 + k)$, its analogue in the annual format is $(1 + r)$. Thus, at the end of the first period ($n$), the cost of capital will be $(1 + k)$ times higher than at the beginning, that is, in the next period there will be compounding. If there are $n \leq 365$ days, then the rate of income ($k$) for the increase will be used $365/n$ times, which will be equivalent to one increase period at the annual rate $r$. If there are $n \geq 365$ days, then the situation is the opposite: the annual rate of return ($r$) for the extension will be used $n/365$ times, which will be equivalent to one increase period at the rate ($k$). The abovementioned can be represented as follows (Eq. 16) (Fisher, 1930):

$$(1+k)^{\frac{365}{n}} = 1 + r; \Rightarrow 1 + k = (1+r)^{\frac{n}{365}}, \tag{16}$$

The given equations are correct because $1 + k \geq 0$ and $1 + r \geq 0$. The obtained expressions are substituted into equation (17) (Fisher, 1930):

$$P_0 = \frac{\sum_{i=1}^{t} CF_i \times (1+k)^{\frac{365}{n}-i}}{1+r} = \frac{\sum_{i=1}^{t} CF_i \times (1+r)^{\frac{n}{365}\times\left(\frac{365}{n}-i\right)}}{1+r} = \frac{\sum_{i=1}^{t} CF_i \times (1+r)^{1-\frac{i\times n}{365}}}{1+r} = \frac{\sum_{i=1}^{t} CF_i \times (1+r)^{\frac{n_i}{365}}}{1+r}, \tag{17}$$

where $CF_i$ is the size of the $i$th element of the cash flow at the moment of occurrence, $n$ is the period separating the elements of the financial flow, in days, $n_i$ is time from the date of purchase of the instrument (the beginning of the operation) to the date of occurrence of the $i$th cash flow, $r$ denotes annual income rate (yield) and $t$ is the amount of revenue earned while using an instrument. To determine the price for the acquisition of government securities and the annual rate of return arising from the date of cash flow, it is envisaged to amend the third equation, that is, equation (18) (Fisher, 1930):

$$P_0 = \sum_{i=1}^{t} CF_i \times (1+r)^{-\frac{i\times n - z}{365}}, \tag{18}$$

where $z$ is the time passed since the date of the last cash flow, in days. The next step in designing the model involves identifying the conditions under which multiple input and output financial flows may occur. In doing so, all outflows should be reduced to the value of the first cash flow (i.e.) at the date of its formation. Thus, the total initial cash flow translated into the cost at the date of purchase of the financial instrument ($PV_1$) is calculated using equation (19) (Fisher, 1930):

$$PV \text{ (source flows)} = CF_0 + \frac{CF_1}{(1+r)^{\frac{n_i}{365}}} + \cdots + \frac{CF_i}{(1+r)^{\frac{n_i}{365}}} = \sum_{i=0}^{t} \frac{CF_i}{(1+r)^{\frac{n_i}{365}}}, \tag{19}$$

The above equation (19) is the total amount of initial cash flows and determines the total amount of investor expenses for the acquisition of government securities portfolio, which takes into account changes in the value of money over time on the basis of their profitability. All repayments are presented as a single metric used to refine equation (17) by changing the purchase price of the financial instrument from ($P_0$) to $CF_0$. That is, after the substitution in the left part of equation (17), the total present value of the outgoing financial flows is formed in the right part – the input is formed. Moving the discounted output streams to the right will change the sign from "+" to "-." Thus, we obtain equation (20), in which all output streams must be subtracted (with the sign "-") and incoming ones are positive ("+") (Eq. 20) (Fisher, 1930):

$$0 = \sum_{i=1}^{t} \frac{CF_i}{(1+r)^{\frac{n_i}{365}}}, \quad (20)$$

is the number of financial flows within the transaction for the acquisition of the investment portfolio and $n_i$ is the period separating the first and the $i$th flows ($n_1 = 0$), in days. If the level of expected return allows an investor to compete for the purchase of government securities or other financial instruments, then the fact of acquisition captures the price that arises as a market indicator accepted by the investor in determining the yield of a depreciated domestic government bond. Thus, the universal model of the expected return on government securities is a dynamic indicator that depends on the changing environment of the functioning of the financial market and the situation of its stock segments, as well as the specific requirements of institutional investors. Moreover, the ultimate profitability of transactions with government financial instruments allows to assess the quality of investors' forecasts and is the basis for their comparison.

## 3. Results and discussion

Within the framework of the Laffer debt curve model, the dependence of GDP change on the level of debt loading of the financial system for the countries forming the economic core of the Eurozone (Germany, France, Spain, The Netherlands and Austria) and well controlling the indicator as well as the new EU member states (Estonia, Romania, Bulgaria, Latvia, the Czech Republic, Poland and Hungary) that have a different level of secure debt loading (Table 1) is mentioned. In the study of such countries, we used the IMF statistics (International Monetary Fund, 2020) with the 2013–2018 time period.

**Table 1.** Average debt loading of the financial system of European Union member states and assessment of the critical value for the period 2013–2018, % gross domestic product

| Member states of the European Union | The average debt loading of the financial system, % GDP | Theoretical evaluation of the value of critical debt | The significance of the connection, $R^2$ | $x_{max}$ % |
|---|---|---|---|---|
| *For the "old" member states of the European Union* | | | | |
| Germany | 74.9 | $y = -5.8961x^2 + 884.23x - 29482$ | 0.6467 | 74.9 |
| France | 83.8 | $y = -1.8171x^2 + 304.5x - 9886.8$ | 0.6955 | 83.8 |
| Austria | 82.3 | $y = -0.3793x^2 + 62.412x - 2152.4$ | 0.5015 | 82.3 |
| The Netherlands | 61.2 | $y = -2.0827x^2 + 254.79x - 6878.6$ | 0.8277 | 61.2 |
| Spain | 78.2 | $y = -0.5162x^2 + 80.722x - 1653.7$ | 0.4564 | 78.2 |
| *For the new member states of the European Union* | | | | |
| The Czech Republic | 41.6 | $y = -0.3009x2 + 22.929x - 225.95$ | 0.5115 | 38.1 |
| Estonia | 9.7 | $y = -0.2184x^2 + 4.6373x - 0.4211$ | 0.7723 | 10.6 |
| Hungary | 77.5 | $y = -0.2169x^2 + 31.675x - 1015.7$ | 0.8600 | 73.0 |
| Latvia | 37.8 | $y = -0.0345x^2 + 1.4461x + 21.958$ | 0.9744 | 21.0 |
| Poland | 51.8 | $y = -1.4725x^2 + 151.89x - 3392.2$ | 0.3319 | 51.5 |
| Bulgaria | 26.9 | $y = -0.095x^2 + 4.2409x + 9.2292$ | 0.4822 | 22.3 |
| Romania | 40.4 | $y = -0.0442x^2 + 4.6517x + 74.643$ | 0.8782 | 52.8 |

**Source(s):** Calculated by the authors according to data [40]

The calculations of the critical debt loading of the financial system of Ukraine within the framework of the "Laffer Debt Curve" model showed the average maximum permissible debt loading pressure for the Ukrainian economy during the period 2010–2018, above which the situation of "debt overhang" may occur 51.2%. Thus, the state of the public finance sector of Ukraine for the period 2010–2014 was characterized by a lack of systematic nature in borrowing. The government mostly made issue loans with the National Bank of Ukraine, and the pressure on the debt loading of the financial system was within 33–39% GDP (Figure 4). Since 2015, the debt loading of the financial system of Ukraine has increased both due to the decline in GDP and due to a significant devaluation of the national currency (almost from 24.00 UAH / $1 to 27.19 UAH / $1), as well as due to increasing the amount of foreign currency debt. The total public and government-guaranteed debt of Ukraine in 2018 amounted to about 92% GDP. During the period 2015–2018, the debt pressure indicator increased more than y 3.5 times. That is, the annual growth rate in 2015 was 123% versus 188% in 2018 (Databases the Ministry of Finance, 2019) (see Figure 5).

Particularly critical for Ukraine is the growth of aggregate debt payments in the medium term, which can largely provoke a crisis of insolvency of the state (subject to uncertainty about further International Monetary Fund lending and a slowdown in economic growth). In 2019, their total amount exceeded 12.4 bn dollars and in 2020, the amount exceeded 12.5 bn USD. Debt payments of Ukraine during the period 2019–2023 are estimated at 64.2 bn USD, including 35.5 bn USD of domestic debt and 28.7 bn USD of foreign debt. In 2019, Ukraine's debt repayments amounted to 10.9 bn USD, in 2020, payments will amount to 11.6 bn USD, while in 2021, 2022 and 2023 payments will amount to 13.7, 14.1 and 13.9 bn USD, respectively (Ministry of Finance of Ukraine, 2019).

Increasing the value of debt restructured financial instruments to 7.75% and pegging them to GDP growth instead of written off 3.6 bn USD will oblige the state to pay creditors over 20 years of 15 or 40% of nominal GDP growth. According to the estimates of the unemployment insurance fund (UIF) in 2022–2027, the additional payments on restructured securities, subject to annual real GDP growth by 4.0–4.5%, the amount of compensation to creditors will amount to 2.5 bn USD. But it will pose an additional threat to the country's financial system as a whole (Amelin *et al.*, 2019). This allowed to determine the model parameters for approximating functions that smooth out the dynamic series of points

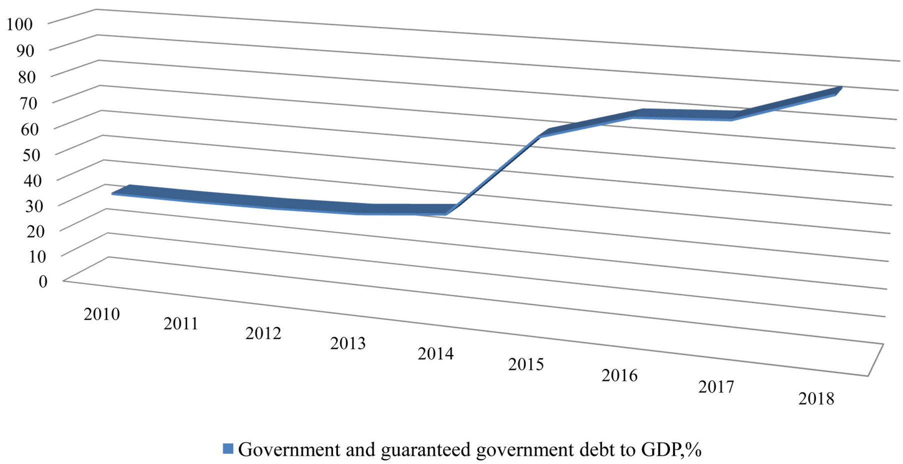



**Figure 4.** Dynamics of change of debt loading of the financial system of Ukraine in 2010–2018

$M2/GDP$ and $DB/GDP$ and compare them with the real and forecast data of the repayment of the national debt in the country (Table 2, Figure 6).

As can be seen from Figure 6, it is appropriate to consider three periods: pre-crisis: until 2020 and post-crisis: 2020–2022 and the period of financial recession and stagnation: 2023–2027, which has a depressive nature of the economic development of the country. This explains the increase in the functional dependence of the behavior of points in the third period.

The dimensionless variables of the post-crisis period for Ukraine in 2020–2022 ($M2^* = M2/GDP$ and $DB^* = DB/GDP$), after the linearization, using the least squares method, allowed determining the parameters that, according to the hypothesis of the logistic curve, determine the functional dependence of the quantities $M2/GDP$ from $DB/GDP$. The analytical expression of the functional dependence of the smooth dimensionless quantities $M2/GDP$ from $DB/GDP$ for Ukraine for the period 2023–2027 was obtained in the form of equation (21) (Laffer, 1979; Levine, 2005):

$$M2^* = \frac{1.27}{1 + 1.23 \times e^{-0.87 \times DB^*}}, \tag{21}$$

The graphical result of the elasticity of inequality (21) for Ukraine has the form (Eq. 22) (Laffer, 1979; Levine, 2005):

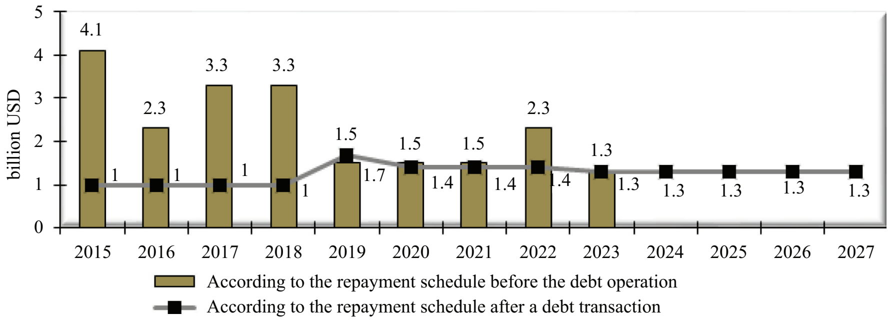



**Figure 5.**
Amount of repayment of public debt before and after debt operation of 2015

**Table 2.**
Smooth time series for approximation functions for Ukraine

| Year | Point number | $M2/GDP$ Real | $DB/GDP$ Real | $M2/GDP$ Weighted $R^2$=0.9309 | $DB/GDP$ Smooth $R^2$=0.8839 |
|---|---|---|---|---|---|
| 2018 | 1 | 0.459099 | 0.142562 | 0.4588 | 0.1860 |
| 2019 | 2 | 0.520965 | 0.118152 | 0.4891 | 0.1931 |
| 2020 | 3 | 0.516621 | 0.196378 | 0.5138 | 0.2141 |
| 2021 | 4 | 0.511992 | 0.341266 | 0.5329 | 0.2485 |
| 2022 | 5 | 0.552633 | 0.406039 | 0.5464 | 0.2962 |
| 2023 | 6 | 0.524303 | 0.368642 | 0.5543 | 0.3567 |
| 2024 | 7 | 0.549256 | 0.375621 | 0.5566 | 0.4299 |
| 2025 | 8 | 0.631595 | 0.415142 | 0.5533 | 0.5153 |
| 2026 | 9 | 0.608118 | 0.710234 | 0.5444 | 0.6128 |
| 2027 | 10 | 0.457429 | 0.730552 | 0.5299 | 0.7219 |

**Source(s):** Calculated by the authors

$$9.1 \times \left(\frac{M2^*}{0.73} - 1\right) \geq e^{\frac{M2^*}{0.73}}, \quad (22)$$

Accordingly, the dimensionless interval $DB/GDP$ has boundary limits |0.485; 0.587|. Figure 7 shows the interpretation of elastic inequality (22) which is represented as the intersection of a direct and exponential function (bold dashed lines). To evaluate the functionality of the Ukrainian securities market, we used the model of multiple correlation-regression analysis, in which the basic factors determine the following elements: first, the yield of government securities ($x_1$) since the rate of return is a direct object of interest of any investor; second, the price index ($x_2$) since the level of return on financial instruments should correlate properly with the level of inflation; third, GDP ($x_3$) as it is a general macroeconomic indicator, reflecting in dynamics and volumes of all reproductive financial processes at the level of the state budget, corporations and households of the country; fourth, the volume of the consolidated budget of Ukraine ($x_4$) since government securities are directly related to the size of the budget deficit; fifth, the total volume of the Ukrainian stock market ($x_5$) since the government securities market is a component of this market. The annual volume of government borrowings to the budget of Ukraine ($Y$) was taken as an effective indicator of the model, which is, in fact, the volume of investments in government securities.

The correlation-regression analysis involves the construction and analysis of the economic-mathematical model of investment attractiveness of government securities in Ukraine in the form of a regression equation of the following form (Eq. 23) (Bayraktar, 2014):

$$Y = f(x_1, x_2, \ldots, x_n) + \varepsilon, \quad (23)$$

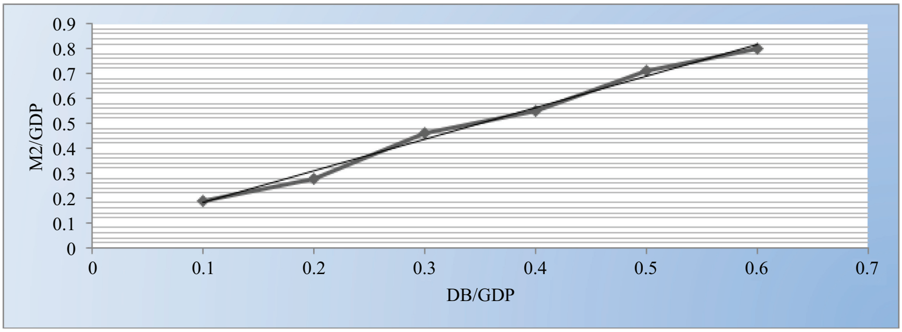



**Figure 6.**
Functional dependence of smooth dimensionless quantities from for Ukraine for the period 2018–2027

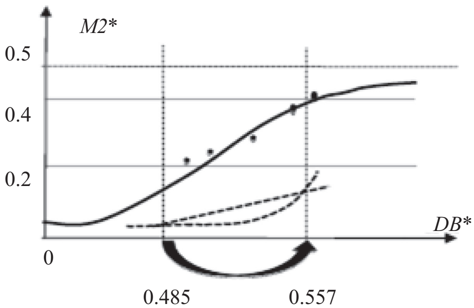



**Figure 7.**
Thelogistic curve for functional dependence of smooth dimensionless quantities for the period from 2020 to 2027 with an interval of the safe level of the public debt of Ukraine

The results of the study allowed us to obtain the following model (Eq. 24):

$$Y = 0.54x_1 - 0.15x_2 + 0.05x_3 + 0.94x_4 - 0.3x_5, \tag{24}$$

Thus, in the system of presented macroeconomic factors, the largest impact on the volume of realized government securities is the volume of consolidated budget and profitability of these financial instruments, the impact coefficients of which are, respectively, 0.94 and 0.54. To determine the degree of influence of the above factors on the volume of investment in government securities (domestic government bonds), the corresponding coefficients of elasticity were calculated using equation (6) (Eq. 25):

$$E = a_j \times \frac{\overline{x_j}}{\overline{Y}}, \tag{25}$$

The results of the calculations are presented in Table 3.

Thus, the coefficient of elasticity shows an increase in the yield of government borrowing by 1%, the amount of funds invested in them and therefore, the corresponding revenues to the consolidated budget of the country increases on average by 0.3%. When the price index increases by 1%, there is a decrease in the volume of funds attracted by the state through the issue of securities by 0.57%. An increase in GDP by 1% causes an increase in attracted funds to the budget through the issue of government securities in the amount of 1.09%. To determine exogenous variables in which the maximum reserves of growth of investments in government securities are laid, we have calculated the beta coefficients using equation (26):

$$\beta = a_j \times \frac{G_j}{G_y}, \tag{26}$$

where $G$ is the standard deviation. Intermediate calculations of beta coefficients are given in Table 4.

**Table 3.** Elasticity coefficients for the constructed model of multiple correlation-regression relation between the factors of influence on the volumes of government borrowings (volumes of invested funds in government securities)

| Average, billion USD | | | |
|---|---|---|---|
| $Y$ | 0.962 | The coefficient of elasticity | |
| $x_1$ | 16.097 | $E_1$ | 0.30 |
| $x_2$ | 0.592 | $E_1$ | −0.57 |
| $x_3$ | 23.459 | $E_1$ | 1.09 |
| $x_4$ | 0.595 | $E_1$ | 0.52 |
| $x_5$ | 28.454 | $E_1$ | −5.31 |

**Source(s):** Calculated by the authors

**Table 4.** Beta coefficients in the model of multiple correlation-regression relation between factors of influence on the volumes of government borrowings (volumes of invested funds in government securities)

| Standard deviation $G_Y$ | 1.5167 | $\beta$ - coefficients | | Changes in the volume of government borrowing, billion USD |
|---|---|---|---|---|
| $G_1$ | 0.4343 | $\beta_1$ | 0.316 | 0.479 |
| $G_2$ | 0.2794 | $\beta_2$ | −0.482 | −0.731 |
| $G_3$ | 17.8559 | $\beta_3$ | 1.133 | 1.718 |
| $G_4$ | 0.7975 | $\beta_4$ | 0.683 | 1.036 |
| $G_5$ | 29.9095 | $\beta_5$ | −0.640 | −0.971 |

**Source(s):** Calculated by the authors

The calculation of $\beta$-coefficients in the multiple correlation-regression model prove that government securities yields in Ukraine can be expected to increase by 31.6%, provided that the volume of investments for economic development increases by an average of 0.479 bn USD. But with an increase in the price index for government securities by an average of 48.2%, it will lead to an outflow of investors' financial flows by 0.731 bn USD. The acceleration of GDP growth by 13.3% will increase the investment in government securities by 1.718 bn USD. An increase in consolidated budget funds by 68.3% will provide an increase in cash inflows into the state budget through the issue of securities by 1.036 bn USD.

## 4. Conclusions

The harmonization of financial market functionality in developing countries in the structure of the global space in order to adjust debt ratios to the limits should be enhanced by the following effective measures:

(1) Implementation of medium-term debt management of the financial system;

(2) Establishing a limit on foreign currency borrowings on the domestic financial market, as well as a general external debt level of no higher than 50% in order to reduce foreign exchange risk;

(3) Preventing interest rate risk in forming the medium-term debt loading of the financial system and developing an additional scenario to respond to rising debt service costs while increasing floating rate loans;

(4) Improving the regulatory framework for fixing the level of debt loading of the financial system with GDP 40%.

This study can serve as a practical guide to optimize government borrowing in Ukraine and other countries. It can become the basis for developing a general strategy for harmonizing the financial market of Ukraine. The use of the studied parameters of the model of approximating functions of dimensionless quantities allowed to determine the corridor of the safe level of public debt in the country, which can help in the future to create norms for the size of debt and establish rigid boundaries for members of the government. The model of multiple correlation-regression analysis, which was used to predict the market functionality of government securities under the influence of factors of government securities yield, the price index of financial instruments, GDP, the size of the consolidated budget and the total size of the stock market can further influence important economic decisions in the country to overcome crisis situations.

## References

Abubakar, A.B. and Mamman, S.O. (2020), "Permanent and transitory effect of public debt on economic growth", *Journal of Economics Studies*, Vol. ahead-of-print No. ahead-of-print, doi: 10.1108/JES-04-2020-0154.

Allen, F. and Gale, D. (1997), "Financial markets, intermediaries and inter temporal smoothing", *Journal of Political Economy*, Vol. 105 No. 3, pp. 523-546.

Allen, F. and Gale, D. (2001), *Comparing Financial Systems: A Survey*, University of Pennsylvania Wharton School, Philadelphia.

Amelin, A., Lavryk, Y. and Khomenko, O. (2019), "Ukraine's default risks become critical", available at: https://uifuture.org/uk/post/ekonomikaukrainy-riski-defolta-ukrainy-stanovatsa-kriticeskimi_448 (accessed 21 March 2020).

Apergis, E. and Apergis, N. (2019), "New evidence on corruption and government debt from a global country panel: a non-linear panel long-run approach", *Journal of Economics Studies*, Vol. 46 No. 5, pp. 1009-1027, doi: 10.1108/JES-03-2018-0088.

Ardagna, S. and Caselli, F. (2014), “The political economy of the Greek debt crisis: a tale of two bailouts”, *American Economic Journal: Macroeconomics*, Vol. 6, pp. 291-323, doi: 10.1257/mac.6.4.291.

Basel Committee (2010), *Basel III: A Global Regulatory Framework for More Resilient Banks and Banking Systems*, Basel Committee on Banking Supervision, Basel.

Basel Committee on Banking Supervision (1988), *International Convergence of Capital Measurement and Capital Standards*, Bank for International Settlements, Basle.

Bayraktar, N. (2014), “Measuring relative development level of stock markets: capacity and effort of countries”, *Borsa Istanbul Review*, Vol. 14 No. 2, pp. 74-95.

Bijlsma, M. and Zwart, G. (2013), *The Changing Landscape of Financial Markets in Europe the United States and Japan*, Bruegel Working Paper, available at: http://bruegel.org/wp-content/uploads/imported/publications/WP_2013_02_01.pdf.

Carson, J. (2011), *Self-Regulation in Securities Markets*, Policy Research Working Paper, Compliax Consulting.

Cooley, P., Roenfeldt, R. and Chew, I. (1975), “Capital budgeting procedures under inflation”, *Financial Management*, Vol. 4 No. 4, pp. 12-27.

Daft, R. (1983), *Organization Theory and Design*, West, Saint Paul.

Danyliuk, V. (2013), “Debt policy of the state: concept, types, peculiarities of realization”, *Bulletin of Odessa National University of Economy*, Vol. 3 No. 1, pp. 115-118.

Databases the Ministry of Finance of Ukraine on the general and guaranteed debt (2019), available at: http://195.78.68.18/minfin/control/uk/publish.

DiPeitro, W.R. and Anoruo, E. (2012), “Government size, public debt and real economic growth: a panel analysis”, *Journal of Economics Studies*, Vol. 39 No. 4, pp. 410-419, doi: 10.1108/01443581211255620.

European Commission (2020), “Numerical fiscal rules in the EU member states”, available at: http://ec.europa.eu/economy_finance/db_indicators/fiscal_governance/fiscal_rules/index_en.htm (accessed 20 March 2020).

Ferguson, N. (2008), *The Ascent of Money. A Financial History of the World*, The Penguin Press, London.

Ferreira de Mendonça, H. and Pereira Duarte Nunes, M. (2011), “Public debt and risk premium: an analysis from an emerging economy”, *Journal of Economics Studies*, Vol. 38 No. 2, pp. 203-217, doi: 10.1108/01443581111128424.

Fisher, I. (1930), *The Theory of Interest*, The Macmillan Company, New York.

Grabowski, W. and Stawasz, E. (2017), “Sovereign bond spreads in the emu peripheral countries: the role of the outright monetary transactions”, *Prague Economic Papers*, Vol. 26 No. 3, pp. 360-373, doi: 10.18267/j.pep.618.

Hartmann, P., Maddaloni, A. and Manganelli, S. (2003), “The Euro area financial system: structure, integration and policy initiatives”, *Oxford Review of Economic Policy*, Vol. 19 No. 1, pp. 180-213.

Holmes, T. (1998), “The effect of state policies on the location of manufacturing: evidence from state borders”, *Journal of Political Economy*, Vol. 106, pp. 667-705.

International Monetary Fund (2016), “IMF Country Report No. 16/319”, available at: https://www.imf.org/external/pubs/ft/scr/2016/cr16319.pdf (accessed 20 March 2020).

International Monetary Fund (2019), “World Economic Outlook”, available at: https://www.imf.org/en/Publications/WEO/Issues/2019/10/01/world-economic-outlook-october-2019 (accessed 21 March 2020).

International Monetary Fund (2020), “The International Monetary Fund databases”, available at: http://www.imf.org/data/imf-finances (accessed 20 March 2020).

International Organization of Securities Commissions (2011), “Methodology for assessing implementation of the IOSCO objectives and principles of securities regulation”, available at: https://www.iosco.org/library/pubdocs/pdf/IOSCOPD562.pdf (accessed 19 March 2020).

Laffer, A. (1979), *The Economics of the Tax Revolt*, Harcourt, Brace.

Levine, R. (2005), *Finance and Growth: Theory, Evidence, and Mechanisms*, Brown University Press, Providence.

Londar, S. (2013), "Level of debt burden of public finances in Ukraine", *Finance of Ukraine*, Vol. 1, pp. 22-31.

Londar, O. (2015), "Improvement of the debt management system of Ukraine in the process of integration into the EU", *Scientific Works of NDFI*, Vol. 2, pp. 57-69.

Ministry of Finance of Ukraine (2019), "National Bank of Ukraine and the Ministry of Finance of Ukraine made on the exchange of bonds of domestic government loans portfolio owned by the National Bank of Ukraine", available at: https://www.minfin.gov.ua/news/view/natsionalnyi-bank-ta-ministerstvo-finansiv-zdiisnyly-reprofailinh-ovdp-z-portfeliu-nbu?category5novini-ta-media (accessed 19 March 2020).

Morselli, A. (2016), "Theoretical approaches on the possible existence of a stabilising economic policy in Europe", *Journal of Economics Studies*, Vol. 43 No. 5, pp. 815-834, doi: 10.1108/JES-03-2015-0056.

O'Hara, M. and Ye, M. (2011), "Is market fragmentation harming market quality?", *Journal of Financial Economics*, Vol. 100 No. 3, pp. 459-474.

Oliinyk, O. and Sidelnikova, I. (2011), "Debt security of Ukraine: state, problems, prospects", *Herald of the Yaroslav Mudryi National Law University*, Vol. 2 No. 5, pp. 41-48.

Omarova, S. (2010), "Rethinking the future of self-regulation in the financial industry", *Brooklyn Journal of International Law*, Vol. 35 No. 3, pp. 665-706.

Pengjie, G. and Qi, Y. (2013), "Political uncertainty and public financing costs: evidence from US", *Municipal Bond Markets*, Vol. 145, pp. 25-36.

Refet, G., Sack, B. and Wright, J. (2007), "The US Treasury yield curve: 1961 to the present", *Journal of Monetary Economics*, Vol. 54 No. 8, pp. 2291-2304, doi: 10.1016/j.jmoneco.2007.06.029.

Schmidt, R. and Hryckiewicz, A. (2006), *Financial Systems – Importance, Differences and Convergence*, Working Paper Series, Vol. 4, available at: https://www.econstor.eu/bitstream/10419/97758/1/IMFS_WP_04.pdf.

Serhiienko, O. (2014), "The construction of the concept determine the specific indicators that point to the critical state of the public debt for the economy of Ukraine", *Young Scientist*, Vol. 9 No. 12, pp. 59-65.

Trusova, N., Kalchenko, S., Tsap, V. and Ternovsky, V. (2017), "Restrictions of financing the budget deficit of Ukraine", *International Journal of Economic Research*, Vol. 14 No. 14, pp. 353-364.

Trusova, N., Karman, S., Tereshchenko, M. and Prus, Yu. (2018), "Debt burden of the financial system of Ukraine and countries of the Eurozone: policy of regulating of the risks", *Espacios*, Vol. 39 No. 39, pp. 312-328.

Vlasiuk, O. and Shemaieva, L. (2016), *Debt Sustainability as a Strategic Direction to Improve the Level of Financial Security*, National Institute of Strategic Research, Kyiv.

## Further reading

Itgovernance.co.uk (2016), "The Basel accords - an overview of the Basel financial refulations: Basel I, Basel II and Basel III", available at: http://www.itgovernance.co.uk/basel.aspx.