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INTRODUCTION

Relevance of the topic. After a long period of the countries' development process, the concept of integration appeared and now it is becoming the more and more relevant over time. In accordance with existing resource bases, technological progress and potentials, every country some time ago started to form the appropriate relationships with other countries in order to create well-organized system of importing those goods and resources which the country feels the need in, and exporting those, which it has or can manufacture on its own. In this way the system of interrelationships occurred between the countries all over the world.

Nowadays there is no such country exist that would fully meet all needs which it has in any field of functioning and would be fully independent from the rest of the countries. One of the most important type of resources for every country are financial ones. A sufficient amount of financial resources gives an opportunity to do investments, to ensure further development of the country and, consequently, to enhance the country's position on the world stage. However, financial resources, as any other, are distributed among the countries and other economic entities unevenly – some of them have a deficit on the resources given, other – vice versa, have free capital that gives them an opportunity to give it to those, who need, in the form of credit.

On the government level Ukraine relates to the row of borrowing countries rather than lending ones. For the countries from this group the public debt is fraught with not only positive aspects, but also a row of threats. That is why the correctness of debt managing is very important. By playing a role of the financial resources source the public debt is intended to improve the economic conditions of the borrowing country, but quite often the row of both external and internal factors, as well as providing nonefficient debt management strategies, lead to the negative consequences which not only do not bring any benefits, but also are able to make the situation in the economic sector of the country even worse.

The purpose and main objectives of the research. The main purpose of this research is to provide an estimation of the debt management mechanism efficiency, the

effectiveness of Ukrainian debt strategy, and to determine the impact of public debt on the country and its economy.

In this research there can be highlighted the following **main objectives**:

- to reveal the notion of public debt and its classification;
- to reveal the preconditions of public debt formation;
- to reveal how the public debt influences on the economy and its development;
- to determine the positive and negative sides of the public debt;
- to reveal what are the core methods and management tools in the sphere of public debt regulation;
- to study the Ukrainian public debt structure, dynamics and its cost;
- to reveal the problems which exist in Ukraine regarding the public debt management;
- to study the public debt of Ukraine by using system dynamics and econometrics methods.

The **object** of the study is a public debt. The **subject** of the study – exploring the Ukrainian public debt dynamics and ways of improving its management.

The first chapter contains the theoretical basis regarding public debt. It reveals the public debt notion, its classification, preconditions of forming, main debt management tools, instruments of regulation and the debt's impact on the country's development.

In the second chapter the Ukrainian public debt is studied. It is highlighted the structure and dynamics of Ukrainian public debt, its cost and an impact on the economy. Also, by using econometrics methods, the Ukrainian public debt is studied in terms of key factors which cause the largest impact on the debt dynamics.

The third chapter includes, firstly, a system dynamics model, built to obtain an understanding of the whole system and the public debt dynamics. Secondly, the core strengths and weaknesses of Ukrainian public debt management, characteristics of its regulation over 30 years of independency and recommendations of how to make the public debt regulation in Ukraine more efficient in the future.

CHAPTER 1 THE ESSENCE OF PUBLIC DEBT, KEY FOUNDATIONS OF ITS OCCURRENCE AND ITS MANAGEMENT

1.1 The notion of public debt, its classification and prerequisites for formation

Every country in today's world is regulated by its government which has a row of duties towards the citizens and the country as such. However, the performance of these obligations depends on the sufficiency of financial resources that the government has in its possession. Thus, there is no need in additional financing and, consequently, in debt, if the government has enough money. On the opposite side, the lack of money forces the governments to take an appropriate measure due to be able to perform its duties and avoid the financial crisis. In most cases this measure is to borrow money.

Nowadays, regardless of the level of development, almost each country has a public debt – even such countries as USA, Japan, Norway, Great Britain etc. (Figure 1.1). The public debt became an integral part to the development process of the countries as a whole and the financial markets in particular. It plays the role of investment funds source and, thus, under the condition of its proper usage, it serves as the driving force of economic development. Generally, the public debt – is the total amount of government's liabilities and interests, including loan guarantees, which occurred as the result of the government borrowing and were not paid back to the lenders yet at the given point of time [51].

The economic essence of the public debt determines the economic relations between the government as the borrower of the financial resources and all lenders regarding the GDP redistribution. As the variety of credit, the public debt sticks to a row of crediting principles and is performed under the following conditions: it should have time limitations, be payable and fully repaid. The first condition implies that the credit has the established time boundaries on expiration of which the money borrowed must be returned to the lender. The second condition means that the usage of money is not free of charge

– in addition to the loan amount the government should pay an interest to the lender. The third condition tells that the credit, surely, ought to be paid back to the fullest extent.

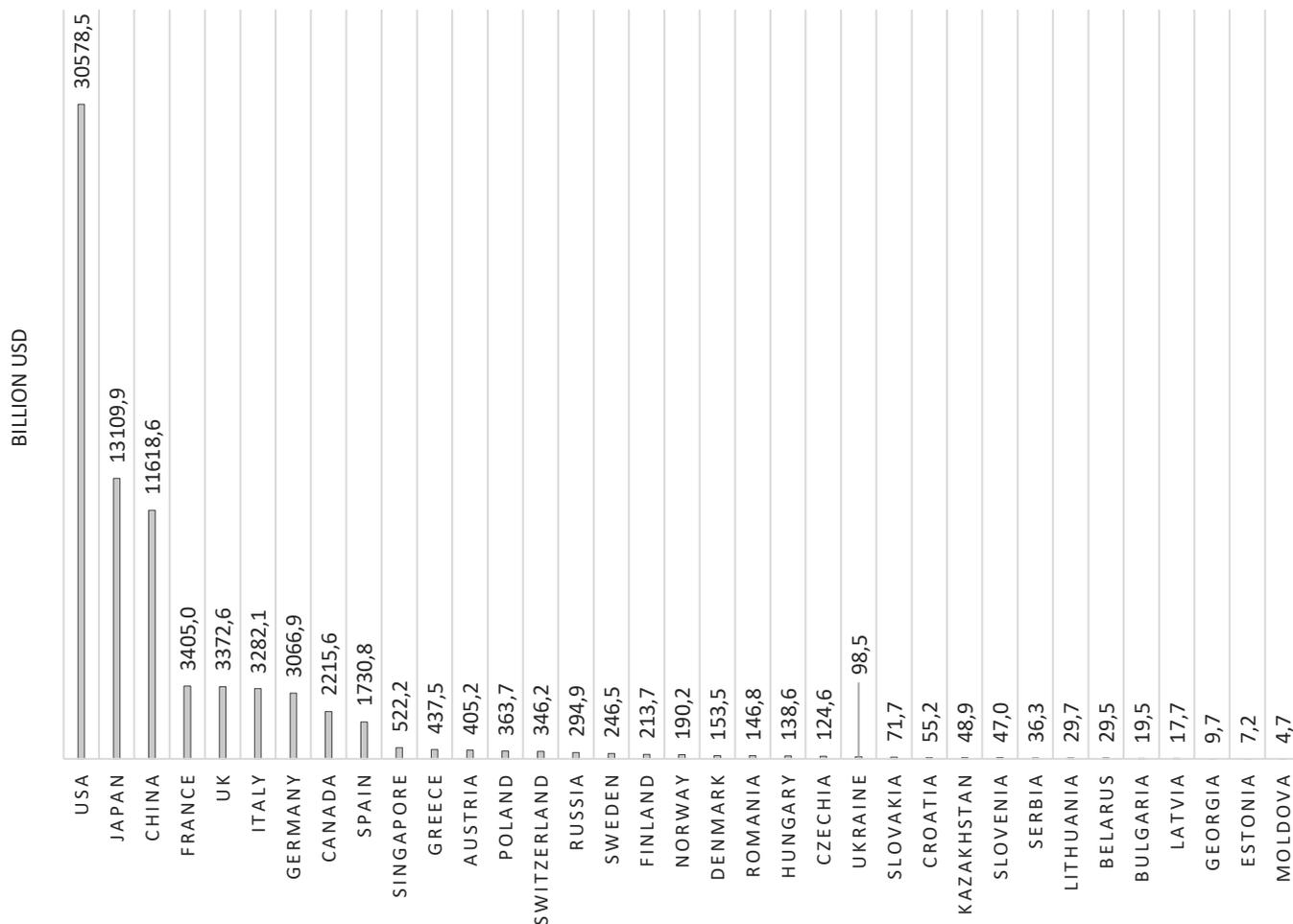


Figure 1.1 – Total public debt by country as at 2021 year

Source: created based on International Monetary Fund and World Bank data [34],[58]

Within the given type of economic relationships, the borrower is always a government, and the lender can be any domestic or foreign economic entity: native and foreign citizens, companies, firms, banks, other governments, supranational unions and international financial institutions (for instance World Bank, International Monetary Fund). The right to perform the government borrowing is granted to the finance ministers and treasury departments, which act on behalf of the government. In Ukraine the right to issue the public debt has the government itself, represented by the Finance Minister of Ukraine by proxy of The Cabinet of Ministers of Ukraine. Exactly The Cabinet of

Ministers of Ukraine determines the core conditions of taking the loans and the conditions and order of issuing the government bonds [51].

The credit repayment and facility fees (debt servicing), in accordance with the loan agreements, are provided at the expense of the state budget of the borrowed. Overall, the government's possibility to pay back the loan, that has been taken not on the domestic market, is mostly determined by the borrower's trade balance – if it is positive, then the country has resources to provide the appropriate operations to pay back its debt and to regulate the balance of payments, if negative – vice versa, the country is incapable to do its obligations and the public debt starts to accumulate. The positive changes in the economy are possible if the government revenues are higher than the debt servicing expenses. In this case the budget deficit will become lower over time and the need in debt will fade away, that makes the country's dependency from the lenders lower and the country's economy more stable.

As any other type of credit, the public debt has a row of functions. The two core ones are fiscal and regulative [6]. The idea of the fiscal function lies in the fund's mobilization – the government has on mind to attract the resources needed in order to finance the budget expenditure and to form the centralized monetary fund. This function reveals itself in government's credits which have been attracted both from the domestic and foreign markets. The second, regulative function, means that by taking a credit, to be more precise, by issuing the securities to the public via the Central Bank on the domestic market, the government's core aim might be not to increase the funds, but to provide a regulation of the money supply volume that circulates in the economy. In this way the government may influence on both currency and capital markets within the country.

As any economic phenomenon, the public debt forms under the impact of different objective and subjective factors. The first group includes unfavorable investment climate, negative trade balance, insufficient manufacturing capacities, insufficient amount of collected taxes that leads to the shortage in the state budget etc. The second group consists of the factors which are the consequence of miscalculations in implementing different policies, reforms and are the result of the absence of clear strategy regarding the further development of the financial market in the country.

Of course, there are many reasons exist why the governments take credits and why it becomes the more and more significant over time. The most primary ones are related to a state budget deficit that is needed to be covered. A state budget deficit, in turn, may be caused by a huge number of other factors. It occurs when the government's revenues, collected from taxes, are lower in comparison with the government's expenditure. In this case the government in fact has two options. The first one is to raise taxes due to increase the funds credited into the budget, the second one – to borrow money. The first option usually is unwanted because it leads to the higher tax burden, that, in turn, causes an increase of the shadow economy percentage, tax avoidance and, thus, does not bring almost any benefit. Besides the budget deficit financing the public debt can also be created in order to finance the government's investing projects for performing which it does not have enough money.

Thus, here are some most frequent motives that can provoke the budget deficit and the follow-up debt creation:

- insufficient amount of tax revenues compared with government expenditures;
- an increase in government costs without an appropriate increase in the government revenues;
- a reduce in tax burden with the purpose to stimulate the economy without an appropriate adjustment of government costs;
- an impact of different political processes and events (for example, elections – a desire to attract more voters can lead to an excessive increase of costs);
- government's willing to cover the state budget deficit;
- government's willing to refinance its already existed liabilities;
- the lack of money to finance different investment projects and programs;
- a replenishment of the reserve assets needed;
- cyclical declines in economy's behavior.

To prevent the need in public debt the country should have an effective and correctly built tax system and low level of shadow economy. Moreover, a big impact on the financial health of the country has an accurate use of public income and the trust of

citizens to the government. The last aspect determines the level of paying taxes among the economic entities and, thus, the government's tax revenues.

The public debt has a quite clear structure. Firstly, the public debt is divided on public debt as such and a guaranteed public debt [23]. The public debt as such implies the amount of borrowed financial resources which were placed directly at the disposal of country's authorities. A guaranteed public debt is the sum of the country's residents' liabilities in which the government plays the role of guarantor which must return the borrowed money to the lender in case of borrower's insolvency. The loan guarantee is provided in the form of government surety. A performance of the loan guarantees creates a potential public debt which becomes a real in case if the borrower is not able to pay back the credit on his own.

The classification of public debt is based on the wide row of its characteristics (Table 1.1). The core division of public debt has been formed in accordance with the source where the financial resources have been taken from. By this principle it is divided into an internal and external public debt. The internal one also can be called the domestic national debt. This component of the total national debt includes only those actual current liabilities which the government must pay back to the citizens and other economic entities withing the country at some points of time in the future. In other words – this is the sum of credits taken on the domestic market and owed to the residents of the country. The external debt (or foreign debt), in contrast, is a component of the total national debt that includes only those liabilities, interests and loan guarantees, which are owed by the country to the foreign lenders (non-residents). Also, loans can be issued either by government or local authorities, thus, are divided in compliance with the issuer [23].

By the form in which the financial resources are attracted, the public debt is divided on the government borrowing and government loan guarantees. The loan guarantees, as it was already mentioned earlier, are the liabilities occurred in connection with borrower's insolvency while the government has the role of guarantor. The government borrowing implies that the government attracts money under the conditions of established time boundaries, payable loan usage and fully repayment. These liabilities, in turn, are divided in two types: an internal government borrowing and external government borrowing.

Table 1.1 The public debt classification by characteristics

Characteristics	Division	
By source:	Internal public debt	
	External public debt	
By form:	Government borrowing:	Internal borrowing
		External borrowing
	Government loan guarantees	
By currency:	In national currency	
	In foreign currency	
By duration:	Short-term loans	
	Medium-term loans	
	Long-term loans	
By pay period:	Current public debt	
	Total public debt	
By type of borrowing:	Nominal public debt	
	Real public debt	
By government role:	Active public debt	
	Passive public debt	

Source: created based on data [23]

An internal borrowing is performed with the help of agreements signed with the residents of the country and securities which the government issues and sells on the domestic stock market. Such securities are called the domestic government bonds. While issuing them the government pledges to reimburse the nominal cost of these securities to their owners and, in addition, to pay them an interest. The domestic government bonds are always issued in an appropriate national currency of the country. Also, this type of securities is considered to be the safest to invest in, because its repayment is guaranteed by the government – exactly its property plays the role of assurance [39].

An external debt can be also generated in a few ways. Firstly, besides that the country can issue the domestic government bonds, it can also issue the government securities for selling on the foreign stock markets. These securities are mostly issued in the foreign and universal currency, such as euro or dollar, and are sold to the non-residents of the country. Secondly, an external borrowing can be provided by a concluded international loan agreements with the foreign government, bank, supranational unions

or international financial institutions. The sources of the external debt reimbursement are the state budget, gold reserves, funds received from the state property privatization and new borrowings.

In comparison with the domestic government bonds, the external borrowing is less beneficial and more dangerous for the country's economy. A foreign debt has a higher risk, cost and, besides this, generates the dependence of the borrower from the lender. By paying back an internal debt and interests which it carries with itself, the country does not lose its financial capacity. In comparison, if the government borrows from the foreign entities, then the emergence of the capital outflow from the country starts to gain strength that negatively influences on country's economy and its further development [27].

The public debt also varies regarding the currency in which the financial resources were borrowed. Thus, the loan can be taken in the national country's currency and in the foreign one. As it was already stated, the internal borrowing is provided by the government exactly in the national currency. In the foreign ones (mostly euro and dollar) the external borrowings are performed. For the countries which have joined the economic union with a common currency for all members (for instance, European Union) and adopted it this division does not work – both internal and external borrowing are mostly provided in one currency and the only main factor to distinguish internal and external debt is a residence of the lenders. But, despite that the internal borrowings are provided in national currency, the total public debt (including guaranteed debt) is calculated in both hryvnia and USD by using an official currency exchange rate of Ukrainian national bank in order to monitor the debt's real state.

The duration of the financial resources usage also matters. Credits taken on less than 1 year are called the short-term loans. The long-term ones have time boundaries of 5 years and longer. All credits with a duration from 1 to 5 years are the medium-term loans.

In accordance with a pay period the public debt can be divided on the current and total. The indicator of current national debt represents the sum of liabilities, all interests and loan guarantees, which must be paid by country within the current year only. The total nation debt – is an aggregate sum of all liabilities, interests and loan guarantees that were not be paid back yet and which the country owes in general. Besides this, one more

type is usually allocated – the net public debt, that is the sum of liabilities without taking in account an interest [23].

Also, the public debt can be nominal and real. The first one includes the government's liabilities and interests occurred on the credit and stock markets. The real public debt consists not only of the nominal public debt, but, in addition, includes all other liabilities which the government owes to the economic entities, such as unpaid public procurement and unpaid wages owed to the budgetary sector workers.

There is one more distinguishing of public debt: an active and a passive. The last one emerges automatically in connection with the budget deficit that, in turn, may be caused, for example, by decrease in the economic entities' income and, consequently, reduced government's tax revenues. An active public debt emerges as a result of an appropriate measures that the government takes in order to overcome the crisis.

1.2 The impact of public debt on the economic conditions of the country and on its development

According to the data of Trading Economics nowadays the increase of public debt volume can be seen in many countries all over the world. Especially it gets higher with the more rapid pace in the developing countries [5]. Since the emergence of public debt notion many scientists have been argued about an impact of this complicated phenomenon on those countries which have ones made a decision to attract some financial resources in this way and play the role of borrowers. On one side, an existence of significant public debt may jeopardize the economic development and negatively affect the financial condition of the country. On the other – the public debt implies under itself an acquisition of additional funds, plays the role of the economic growth stimulating force and gives an opportunity to invest in the prospective industries and spheres. By attracting the public debt, and with the help of appropriate investing decisions, regulations and efficient usage of the financial resources, the governments can increase the production capacities of the country, national income and welfare of the citizens [1].

In accordance with the nature of economic consequences which the government liabilities can lead to, they can be divided on short-term and long-term ones. The short-term consequences reveal themselves in the displacement problem, the long-term ones are known as debt burden. An effect of displacement emerges as the result of refinancing the state budget deficit via providing new borrowings. Such financing leads to an increase of interest rates on the national market. Because of this, the credits for domestic economic entities become too expensive and non-lucrative for providing investment projects, thus, the investments in the real sector of the country start to displace from the market [27].

The long-term consequences of public debt are linked with its impact on the capital accumulation process and the future generation's consumption (long-term economic growth) [24]. The debt accumulation and an increase of interest rates on the domestic market in long run usually leads to the situation when the volume of investments in the private sector decreases while people start to place their saving into the government securities. Thus, because of the private investments' absence, the debt accumulation leads to a decrease in the manufacturing capacities of the country that, in turn, slows down the economic development and leads to the reduce of incomes. At the same time, if the debt management in the country is efficient, then it does not harm the economy, vice-versa, stimulates to even rapid development.

Overall, all consequences which the debt can lead to can be as positive, as negative. One of the main requirements that are needed to be fulfilled to ensure an economic growth of any country are investments. Without investments and a sufficient amount of money the country will be in stagnation with no opportunities of further development. Thus, for many countries, especially undeveloped and those, which are in the process of developing, the public debt is one of the few ways to accelerate the economic growth.

The effectiveness of public debt regulation can be estimated by the impact that is caused by debt on the economy. A general scheme of effective debt usage and its impact on the economy is shown on the Figure 1.2. The most effective usage of debt is to transform the funds borrowed in the investment in human capital and innovations. Such investments contribute to the emergence of scientific and technological progress which helps to develop business activity in intensive way instead of extensive one. As the result,

the effectiveness of business activity increases, the need in new government loans decreases and country has more funds to invest in its further development. In addition, such dynamics in the issue of public debt makes the investment climate of the county better, that attracts more foreign investments and also has positive impact.

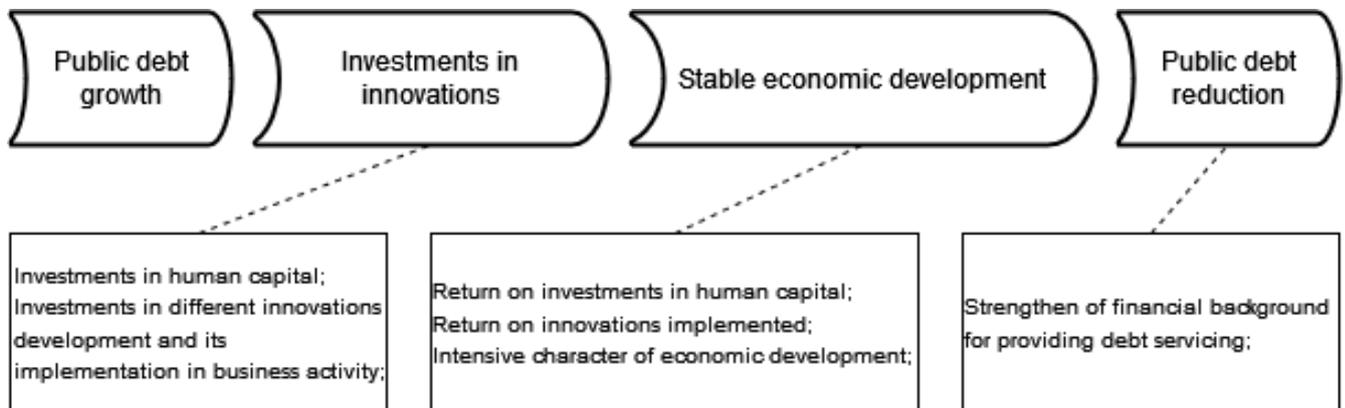


Figure 1.2 – A scheme of effective debt usage

Source: created based on [62]

As it was already stated, the more preferable type of public debt for any country is an internal one due to the lower number of possible negative consequences which it may cause. The problem is that not in every country the population has free capital to invest in the domestic government bonds. Furthermore, even if it has, investing in the government bonds can be not very common among the residents because of the low trust to the country's authorities. Hence, if the government cannot attract the financial resources on domestic market, it is forced to invoke external borrowing.

The advantages of internal debt over an external are quite numerous. Firstly, in the case of internal borrowing the debtor (government of the country) can determine the conditions of funds lending by itself, even interest rates, while the external borrowing implies no possibility for borrower to somehow influence on the credit conditions establishing process. The lenders in the internal borrowing occasion do not have an impact on the borrower and cannot dictate the circumstances of crediting and debt repayment. This feature is characterized only for internal debt and gives all benefits to the debtor [23].

Secondly, an internal debt implies lower cost and, in addition, benefits from the absence of the foreign exchange risk. The thing is that the interest rates for the domestic

government bonds are defined directly by the government of the country-borrower, consequently, the cost of such credits will be lower in comparison with those which have been granted by foreign lenders. Moreover, the currency market cannot be called stable and from the state's perspective it is much more safer to have liabilities in national currency rather than in foreign one in order to exclude a threat of debt increase because of the national currency depreciation [23].

Thirdly, the domestic government bonds issuing (or purchasing) can be provided by authorities as a monetary policy measure to regulate the inflation processes and stabilize a domestic financial market. With the help of internal borrowing the government can either expand (in case of deflation) or reduce (in case of inflation) the amount of money supply and influence the exchange rates on the currency market [23].

One more advantage is that the internal borrowing does not harm the country's independency on the world stage and its reputation. In contrast to the internal debt, the external one creates a strong dependance between the borrower and lender. In case of late repayment of the credit or its absolute absence, the foreign governments or international institutions have a right to apply the appropriate sanctions and restrictions in political or economic manner against the borrower that can blow up the stability of borrower's economy. In addition, in the context of business reputation, if the country is incapable to pay off its liabilities, then it starts to lose the trust of other entities, that instantaneously reduces the chances to receive a financial assistance in the future [23]. At the same time, the prompt returning of funds shows that the borrower uses the funds in effective way and increases the assurance of the foreign lenders that the money invested in this country will pay off and be returned on time in case of future borrowings.

One more aspect of internal borrowing lies in the mutual benefit between the authorities and domestic economic entities. As the last ones play the role of creditors, the government becomes interested in the increase of their revenues, as well as in the business development, because the raise of income leads to the increase in individuals' and legal persons' capability to be a source of crediting.

Despite all the benefits that the public debt can bring, the threats of its usage can be very destructive and dangerous for the economy. Logically, all benefits of an internal

borrowing which have been described above also serve as the disadvantages of external borrowing, but the list of threats that the foreign debt has is much longer.

As it is known in the investing sphere, the lower the risk is, the lower is the interest rate. The international credit market is not an exception and works in accordance with this rule as well. The trust of lenders to the borrower plays a huge impact on the conditions under which they are ready to give the funds. The non-fulfillment of the liabilities, which the country has, undermines the confidence of lenders to the borrower. This, firstly, narrows down the number of institutions, governments and other entities which are ready to provide a credit to such borrower in the future and, besides this, forces those, who are ready to lend, to demand higher interest rates due to high risk of default.

The more developed economy the country has, the easier it is for this country to accumulate financial resources, pay back the funds it has borrowed and gain the trust from lenders, but still, even in occasion of successful credit repayment, external debt has a negative aspect – the capital outflow from the country (in the form of debt servicing).

For the undeveloped and developing countries everything is exact opposite. Such countries mostly have weak and unstable economies, which often have a chronic budget deficit, and it is hard for them to generate a sufficient amount of financial resources during the established by the credit contract period and fulfill its liabilities in time. Moreover, besides the credit itself, the payments regarding interest rates start to accumulate. Thus, in comparison with developed countries, the undeveloped and developing ones, firstly, borrow money for higher cost and, secondly, have lower productive capacities, as the result – the country is incapable to return the credit. The government starts to feel the need both in refinancing current liabilities and in financing the budget deficit. One of the measures which the government can take in this occasion is to increase taxes in order to receive more money in the form of tax revenues, but this has its own consequences – for example, an increase of tax avoidance and the raise of shadow economy, that will not lead to the greater government revenues and provoke even greater deficit.

The second option implies an attraction of money via internal borrowing – the government increases the interest rates of the domestic government bonds to make them more beneficial for investors. But, this measure also can cause negative effect. If the

bonds become more lucrative, then the investors will prefer to invest in them rather than in a private sector and it will slow down the pace of economic growth.

The third way is refinancing the old liabilities by new external borrowings. It means that the government take new credits, even with a higher cost, and provides a repayment of its previous borrowings. This serves as the point of the vicious circle appearance, or in other words – debt spiral initiation (Figure 1.3), and the debt starts to accumulate.

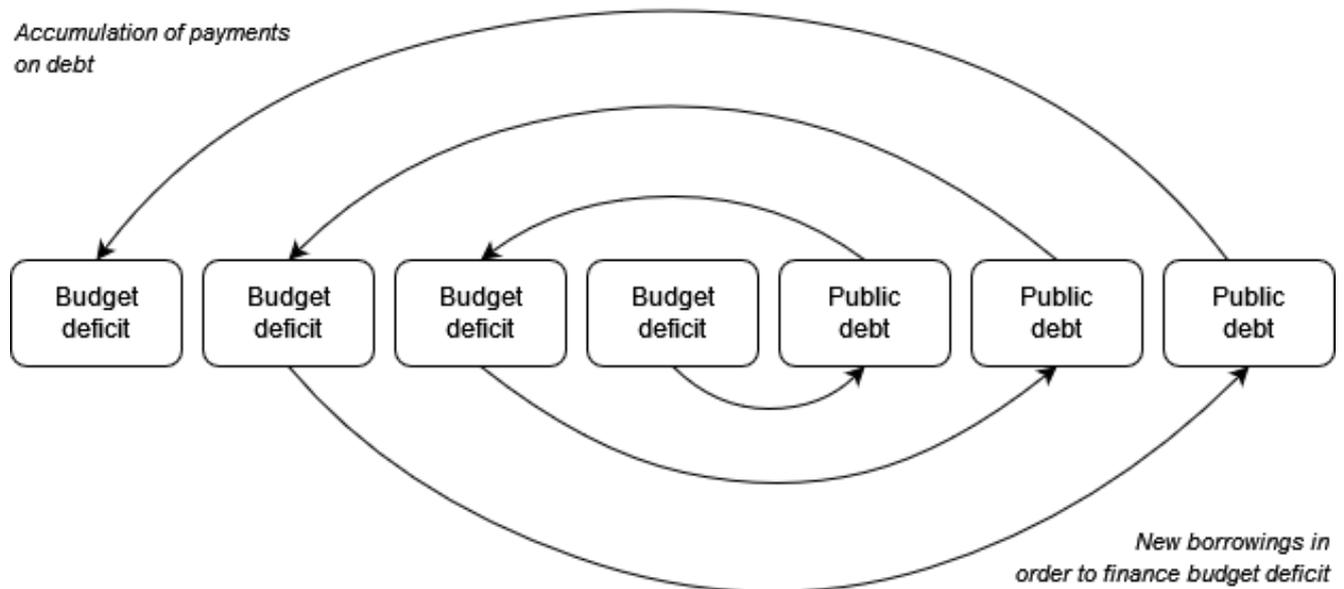


Figure 1.3 – The scheme of debt spiral

Source: created based on data [28]

In fact, such method is not an effective way to get rid of the debt. A negative effect of inappropriate public debt usage is shown on the Figure 1.4. By allocating the funds borrowed on the old loans repayment or on the state budget deficit financing, the government loses the opportunity to invest the new funds received in more lucrative way – in its manufacturing capacity. Such public debt usage does not have any positive return and the business activity starts to develop extensively and reduces. Moreover, as the result of permanent lack of funds, the risks of debt spiral or default emerge. Thus, there is a positive correlation between the budget deficit and a public debt – the budget deficit increases the public debt, which, in turn, requires an additional expense from the budget on its servicing, that leads to a further increase of budget deficit.

The biggest threat that the debt spiral brings in itself is a possibility of sovereign default. In this case the country becomes absolutely non-attractive to investors because now the investment climate becomes unfavorable, so the borrowing nation remains with no external financial support. It all jeopardizes the stability of the domestic currency that can collapse and, consequently, the economic growth will stall [15]. In the conditions of default, it becomes very hard for the debtor to repay all its liabilities and, in addition, cope with penalties which the creditors may apply against it.

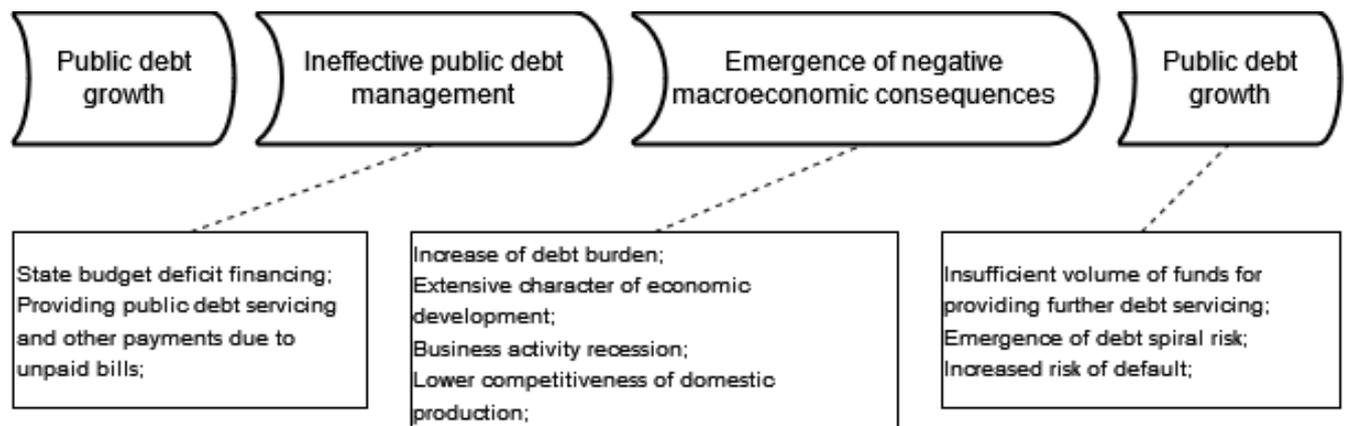


Figure 1.4 – A scheme of ineffective debt usage

Source: created based on [62]

So, the conclusion can be made that the best option while providing an external borrowing is to invest the money received in country's real sector rather than refinance previous liabilities. In this case the funds invested help to boost economy, the companies start to receive more profits. In the result, they have an opportunity to rise employees' wages and the purchasing power of the population increases, people spend more, and the economy develops with greater pace that allows to generate sufficient funds for the loan repayment in appropriate time boundaries and gain the trust on the world stage.

1.3 Methods and the core public debt management tools

The core and the most important aspect in the issue of public debt and in determining its impact on the economy is the correctness of its regulation. The existence of public debt, together with the knowledge about all possible negative and positive consequences

which it can lead to, generates the serious need in creation an effective and well-defined strategy regarding debt management, that, as it was already stated, is one of the key factors which determine the debt efficiency and productiveness of its usage. The successful strategy allows to produce and sell more goods and make a profitable return that is needed to payback the country's liabilities and ensure the further economic growth.

Generally, the public debt management – is the complex of actions and measures which the government takes (in the person of authorized bodies) in order to define the acceptable loan conditions, the funds allocation and repayment, and to ensure the country's solvency [25]. In general, there can be highlighted several core principles of debt managing:

- obligatory repayment – the government's main aim should be to ensure by effective management the performance of all duties which it assumed as the debtor and, consequently, owes to creditors and investors;
- integrity – while managing the public debt the government should take into consideration all liabilities which have been already emitted by both central and local authorities;
- risk reduction – the government should take and repay its liabilities in such way, which will allow to reduce the impact of the world's capital market fluctuations and speculative trends of the stock market on the government liabilities;
- the structure optimality – the government should maintain an optimal structure of its liabilities in accordance with their period of validity and time of repayment in order to avoid or smooth the peaks of payments;
- financial security preservation – the government should pay attention on its liabilities structure in terms of the creditors' residence and try to replace the external debt with an internal one over time in order to safe its independence from lender and avoid funds outflow from the country;
- the debt cost reduction – if possible, the government should act in the way that will allow to reduce the debt cost (for example, by early repayment of its liabilities);
- transparency – the government should ensure the openness and transparency of its liabilities (their feasibility, usage and repayment processes) [24].

According to the “Guidelines for Public Debt Management” prepared by the Monetary Fund and World Bank, the main objective of public debt management is to ensure that the government meets the financing needs and its payment obligations at the lowest possible cost over the medium to long run, consistent with a prudent degree of risk [13]. By the debt regulation the government must gain the biggest effect from investing funds and try to avoid the macroeconomic difficulties and problems with country’s balance of payments in the future.

The debt regulation usually is performed in the context of the budgetary procedure, where, with the help of the “State budget act” on the appropriate year, there are set a row of limits and boundaries for debt: such as debt limit and government guarantees limits regarding the debt repayment. The debt managing process contains three stages: the funds attraction, investing and providing repayment. The long-term aim of the public debt managing is to maintain the volume of liabilities on the level that the government can keep servicing and ensure good performance on all three stages.

The volume of an external borrowing for many countries usually is defined under two factors: firstly, how much capital the country can absorb and, secondly, what volume of debt servicing will be safe for the country due to safe its independence, and what volume of debt servicing the country will manage to provide without the high risk of insolvency. While estimating these factors, the government should consider both short and long-term debt characteristics [25].

An investment of funds borrowed is a core element of the whole debt managing system. These financial resources should be invested with an intend to rise the country’s manufacturing capacities and increase goods produced volume both for internal use and exporting (due to receive the foreign currency that is needed to pay back the debt). All possible risks should be carefully monitored and counted while managing the debt. These risks, in case of occurrence, should be smoothed by the effective debt guidance and by appropriate government’s measures [13].

The government’s policy regarding debt regulating can be divided on the debt tactics and debt strategy. The debt tactics emphasizes on the current concerns and short-term liquidity of the country. The debt strategy is the complex of actions and measures that the

government performs in order to avoid the problems with debt in long-term prospective and to assure its solvency. The final goal is to receive as high positive effect from the investing the funds borrowed as possible [24].

The main debt management methods are conversion, consolidation, unification and the loan postponing or annulment. The conversion implies the change of loan's yield. The government, as a rule, reduces the interest rates which should be paid for the credit due to decrease the debt burden [31].

The second method, consolidation, is about the time boundaries increase. The government in such case receives some extra time to generate the funds needed and successfully provide the loan repayment. These two methods quite often are used in a complex with each other – thus, the borrower can make the loan cheaper and, in addition, postpone the time of repayment.

The unification of loans is the association of several liabilities in a single whole. It is provided in the way when the previously issued bonds are replaced by one new with different interest and other conditions.

The postponing of repayment time mostly is provided when an issuing of new liabilities is not financially reasonable because all the revenues, earned with the help on funds borrowed, go to the existed debt servicing. The debt annulation means that the government rejects to repay the debt. Such method can be only used if the country borrowed is financially unable to repay the debt (in other words, if the country becomes bankrupt) or because of the political motives.

If the country becomes insolvent then it can be said that it has a debt crisis. Its overcoming implies the debt volumes stabilization and its structure changing. For ensuring the country's solvency a row of debt policy adjustment tools exists. The most common ones are the debt refinancing and a restructuring of liabilities [25]. The debt refinancing – is the repayment of existing liabilities and its interests by taking new loans. For successful implementation of the refinancing mechanism a high financial reputation of the country which borrows is required. On the world financial market the debtors' reputation is revealed in the appropriate ranks which are assigned to the country by a special agencies in accordance with international rules.

The idea of liabilities restructuring lies in the debt burden decreasing via changing the borrowing conditions. The main precondition for starting the procedure of debt reconstruction is a consent from both parties – a written agreement between the debtor and creditor, that also contains an arbitration agreement, where it is stated that both parties agree to change the debt conditions. These changes, of course, are beneficial for the borrower who currently do not have an opportunity to repay its liabilities. The debt restructuring mostly is provided within the “Paris Club” [26]. Here the countries-lenders offer to the countries-borrowers in aid one of the following options:

- partial cancellation of debt;
- the debt time boundaries extension;
- reducing the loan’s interest rate.

Thus, the government who borrowed, and another institution who lent the funds, can make a special agreement due to make the debt burden lower and help the borrower to fulfill its liabilities.

The important thing that is required for providing an efficient management, is an understanding that each economy is unique and in every country the public debt has its own specific. The countries vary according to the level of inflation, corruption, an efficiency and development of manufacturing, finance, social sectors, and all these factors should be taken in consideration while designing a public debt regulation strategy. Unfortunately, the history and experience show a lot of cases of damaging and ruining impact of public debt creation that harmed the country’s economy in connection with an inappropriate planning process and an attempt to provide an adoption of the foreign country’s strategy in overcoming the public debt.

At the same time, there is a big number of countries which have a public debt and, despite this, have successfully realized an opportunity to become the high developed entities. Thus, the public debt not always leads to the country’s bankruptcy or its poverty. The public debt existence as such and its absolute values cannot demonstrate a real state of affairs in the public finance sector and, hence, it is not a good macroeconomic indicator. The more illustrative and preferable tool to monitor the country’s debt burden and to compare the indicators of different countries, that had been adopted all over the

world, is to compare the relative values. Therefore, the public debt has the economically feasible boundaries which help to monitor and control the debt dynamics.

The key and most frequently used indicator is debt to GDP ratio. Its level determines how likely the country will pay back its liabilities (both already existed and future ones) [1]. The debt to GDP ratio is also a main characteristic of the debt dependency of the country from the lenders. If it is on high level, it means that the country has many liabilities to its creditors. It also indicates that an accumulating process of debt takes place, that, in turn, can demonstrate that the country has problems with providing debt servicing and its repayment, consequently – repulses the investors.

The International Bank for Reconstruction and Development considers that the critical level of the ratio given is 80% and higher. In contrast, the World Bank set this indicator at the level 77% [1]. Investors usually look at this ratio due to compare the level of risk. When this ratio in the country reaches this critical level, investors start to determine higher interest, that contributes to the increase of the default possibility and the debt spiral creation. Thus, the main idea is that the higher this indicator is, the higher is the risk of repayment absence. However, these digits still require from investors to study the public debt of those countries which are the potential investment receivers from an investor given. For example, as at 2021 year, the USA places the 5th position by the debt to GDP ratio among the countries all over the world (Figure 1.5), while the less developed countries are on the lower positions. While estimating the risk of investing just by looking at digits then there can be missed a lot of important and significant aspects – for instance, the USA's public debt mostly consists of internal borrowing, while the debt in other countries has a big share of external liabilities. Thus, despite the high debt to GDP ratio, the USA's economy is much more stable and safer to invest in, than in other countries' economies and it is very important to understand such details in the sphere of investing and debt managing.

Despite the international recommended standards and accessible limits, every country regulates its debt policy by itself via legislation. For example, in 1992 year all EU-countries signed a Maastricht Treaty where the critical value of this ratio was

established as 60% [8]. In Ukraine, by analogy to the European countries, the higher border of debt to GDP ratio is also set as 60% [56].

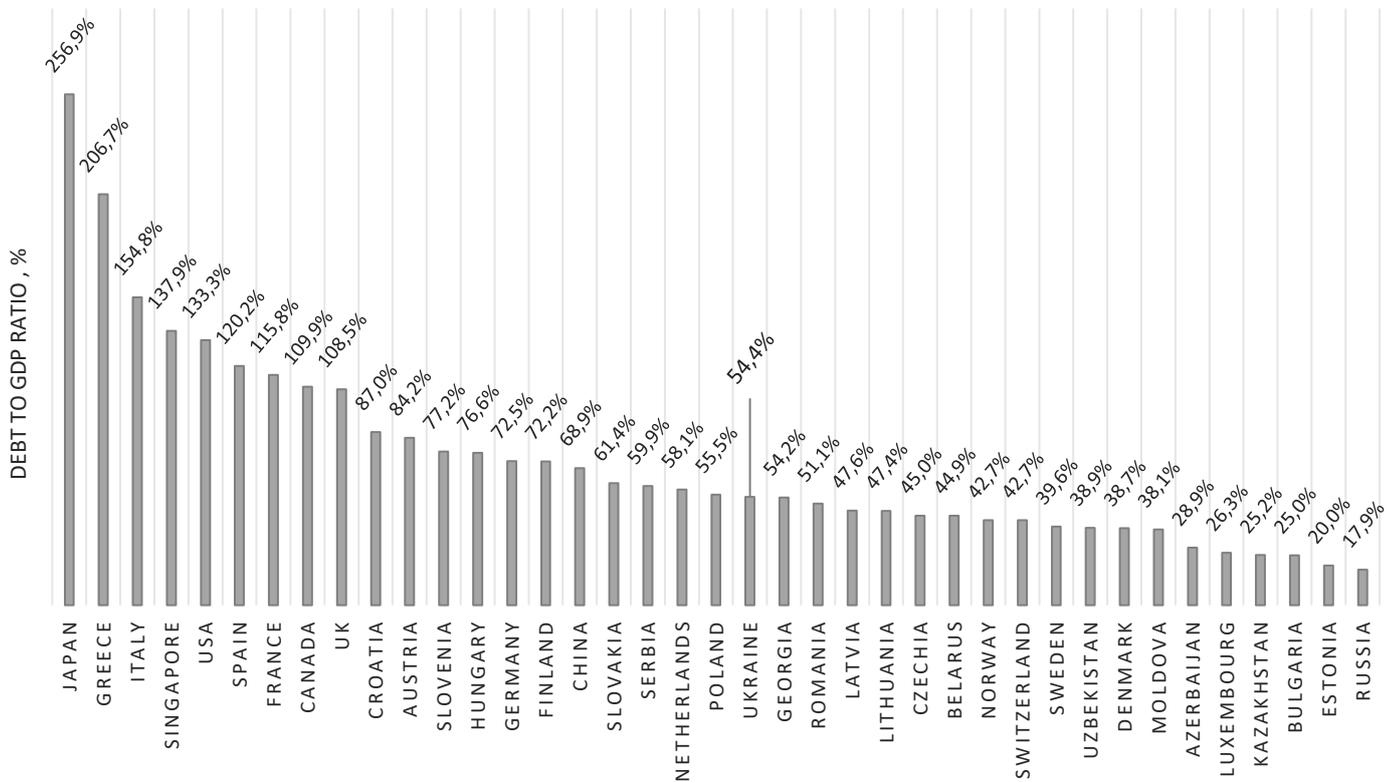


Figure 1.5 – Total debt to GDP ratio by country as of 2021 year

Source: created based on the World Bank data [34]

The row of countries, which debt is considered to be higher than the normal level, also includes those ones whose ratio between the debt size, together with interest payments that should be done, and export exceeds 220%.

There is one more indicator that usually is counted while providing a debt service – debt service ratio (DSR). For the external debt it is calculated as the ratio between all payments regarding external liabilities and the foreign exchange earning of the government, represented in relative values. The satisfactory level of this indicator equals approximately to 25% [27].

So, today, under the conditions of integrity to the world's economy and because of impossibility for each country to fully meet all its needs by itself, the countries started to assist each other in the issue of financial support. As follows – the public debt became an integral part of every economy. The main reason of the public debt emergence is the state

budget deficit that is needed to be covered and, consequently, forces the authorities to take public debt on the internal or external market. Besides this, the need in taking debt by government can be also caused by a willing of authorities to finance certain investment projects and programs which it does not have enough funds to provide. Overall, the role of creditors can be played by different supranational unions, international financial institutions, other governments, banks, native and foreign companies and citizens.

In general, public debt aims to support the economy of debtor and, in case of effective funds usage, can help to boost the economic development. At the same time, the public debt notion also implies a row of different threats and risks for the borrower which may do harm and negatively influence on the wellbeing of the whole population of the country and its further development. The most dangerous threat is a debt spiral, that occurs in result of covering a chronic budget deficit by taking new loans and low effectiveness of debt usage, that can jeopardize the country's stability and solvency.

As Ukrainian national currency is not US dollar or Euro and as Ukraine takes loans not only in hryvnia, the exchange rates fluctuations have very high significance in the issue of public debt. A deflation of national currency can significantly increase the debt burden on the domestic economy that also negatively influences on the population's wellbeing and economic development.

A set of all possible negative consequences of public debt gives an understanding of an effective public debt management importance. To the core principles of such regulation, which ought to be ensured, can be added the following ones: obligatory repayment, integrity, risk reduction, the structure optimality, financial security preservation, the debt cost reduction and transparency.

There are many methods and tools which the government can use in the process of debt attraction, its investing, servicing and which can help to smooth the negative consequences in case of ineffective debt regulation, but the key thing here is a detailed and careful debt strategy planning. If it is well-performed, then the country will benefit from the debt attraction, if it is not, then there is a high risk of jeopardizing the whole economy and a long suspension of further economic growth.

CHAPTER 2 AN ESTIMATION OF UKRAINIAN PUBLIC DEBT MANAGEMENT EFFICIENCY

2.1 The structure and cost of the public debt in Ukraine

The core thing that mostly determine the effectiveness of public debt regulation and its usage is, of course, the strategy which the government implements and uses in terms of public debt regulation. As the success of the debt regulation is directly linked with the economic stability and country's solvency, it is important to rely on the relevant and influential data while designing it.

To create an adequate plan and give reasonable recommendations regarding the public debt regulation, the row of debt indicators and debt security indicators are used. Overall, the debt security is the level of internal and external debt, with taking into account servicing costs and the effectiveness of its usage, that would allow to meet all social and economic needs and, at the same time, would not jeopardize the country's sovereignty and ruin the financial system [9]. Such indicators include debt to GDP ratio, debt per capita ratio, external debt to yearly export ratio, external debt servicing costs to yearly export ratio, internal debt servicing and repayment costs to GDP ratio, debt servicing costs to government revenues ratio, debt to government revenues ratio, the level of external public debt in the total government revenues and other. Thus, by analyzing all these indicators those charged ones can obtain an understanding of overall state of public debt and design an appropriate strategy of public debt regulation.

The first thing that should be observed while analyzing the public debt is its amount. By the general government gross debt volume as of 2020 year Ukraine takes 52nd place out of 190 countries [10]. In the Table 2.1 it is shown the Ukrainian public debt dynamics from 2011 to 2021 year in two currencies – Ukrainian hryvnia and US dollar.

According to the Ukrainian Ministry of Finance, the public debt of Ukraine as of the end of 2021 year equals to 2 671 827,6 mln UAH, or 97 947,4 mln USD [45]. Generally, the public debt in Ukraine for the last 10 years has increased on 2 198 706,0 mln UAH.

The changes in USD are 38 731,7 mln, but more representative will be relative values of such changes. Thus, starting from 2011 year, the public debt multiplied 5,6 times in hryvnia and 1,7 times in USD.

Table 2.1 Ukrainian public debt dynamics for 2011-2021 years

	Total public debt, Million UAH	Yearly growth rate	Total public debt, Million USD	Yearly growth rate
2011	473 121,6	+ 9,5 %	59 215,7	+ 9,1 %
2012	515 510,6	+ 9,0 %	64 495,3	+ 8,9 %
2013	584 114,1	+ 13,3 %	73 078,2	+ 13,3 %
2014	1 100 564,0	+ 88,4 %	69 794,8	- 4,5 %
2015	1 572 180,2	+ 42,9 %	65 505,7	- 6,1 %
2016	1 929 758,7	+ 22,7 %	70 970,9	+ 8,3 %
2017	2 141 674,4	+ 11,0 %	76 305,2	+ 7,5 %
2018	2 168 627,1	+ 1,3 %	78 323,0	+ 2,6 %
2019	1 998 275,4	- 7,9 %	84 364,5	+ 7,7 %
2020	2 551 935,6	+ 27,7 %	90 255,4	+ 7,0 %
2021	2 671 827,6	+ 4,7 %	97 947,4	+ 8,5 %

Source: created based on Ukrainian Ministry of Finance data [45]

The table above also demonstrates how the debt is changing under the impact of economic instability. In 2014 and 2020 years it can be observed sharp jumps of debt's amount in Ukrainian national currency, despite the absence of such increases in USD. In 2014 year the public debt volume decreased from 73 078,2 mln USD to 69 794,8 mln USD – on 3 283,4 mln USD (became less on 4,5%) while in national currency the changes are completely opposite – the public debt not only did not decrease, but increased from 584 114,1 mln UAH to 1 100 564,0 mln UAH. It's on 516 539,9 mln UAH in absolute values and on 88,4% in relative ones.

This difference in public debt's trends in terms of currency can be explained by hryvnia's devaluation that was happening in these years in connection to crisis emergence (Russian invasion in Crimea in 2014 and COVID-19 pandemic in 2019). Such behavior of public debt is a manifestation of one of the main threats for the country's economy that the debt has – the risk of currency. Since the issue of currency is mostly related to the

external borrowing, it is important to study Ukrainian public debt structure in terms of fund's source (Figure 2.1).

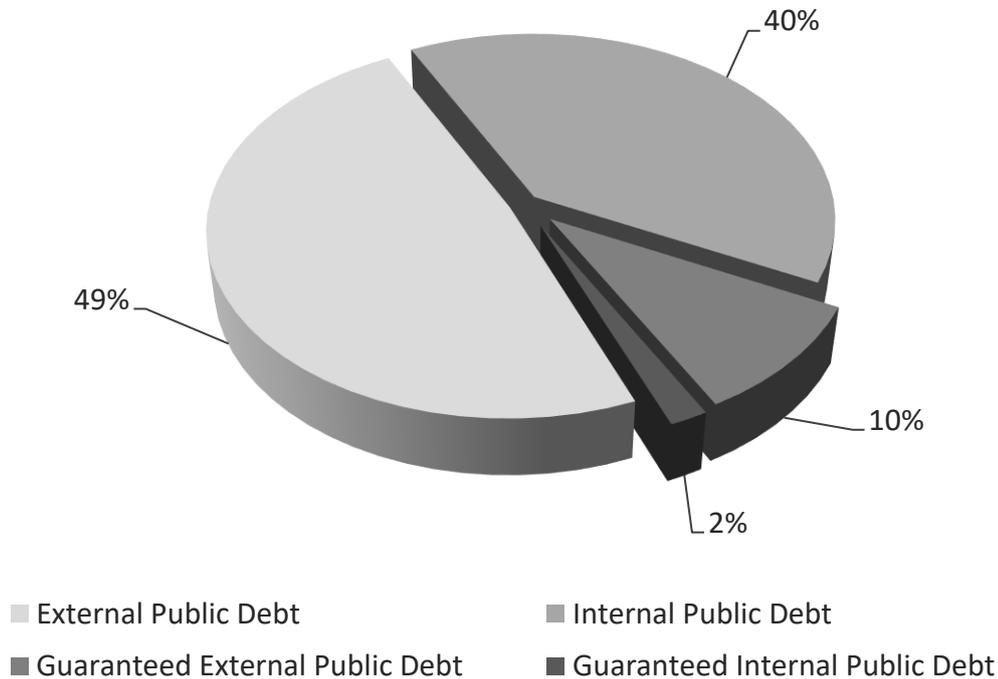


Figure 2.1 – The structure of Ukrainian public debt by source as of 2021 year
Source: created based on Ukrainian Ministry of Finance data [45]

According to the data of Ukrainian Ministry of Finance the largest share within this structure in 2021 year accounts for an external public debt. Its share is equal to 49%. The internal debt reaches 40% of the total debt, other 12% are related to the guaranteed public debt (2% – guaranteed internal debt and 10% – guaranteed external debt). So, the external debt in total (both external public debt and guaranteed external public debt) reaches 59%. The more this indicator is, the more sensitive the public debt is to the fluctuations in currency exchange rate and the more jeopardized the whole economy is, that is why a minimization of the external debt share in the total public debt structure should be one of the core aims while designing an effective public debt regulation strategy.

As it was already said, an internal debt is more beneficial and less dangerous for the economy, so every government would give its preference exactly to the internal one. However, it is impossible to satisfy all needs of the country without other countries assistance, even for such developed countries as USA, Great Britain, Germany and Japan.

That is why there is no country exist in today's world which would not have an external debt at all and would be able to cope with all needs by itself [17].

Ukraine is deeply integrated in all economic processes which are happening in the world and, as every part of the system, is connected to many other countries. Especially to those which contribute to development of Ukraine by lending funds. The data of the Ukrainian Ministry of Finance indicates that as of the end of 2021 year the largest liabilities Ukraine has to such international financial institutions as International Monetary Fund (239,5 billion UAH), International Bank for Reconstruction and Development (167,9 billion UAH) and European Economic Community (136,4 billion UAH). Among the foreign governments to which Ukraine has the largest debt there are Russia (16,53 billion UAH), Japan (13,61 billion UAH), Germany (7,82 billion UAH) and Poland (1,14 billion UAH) [50].

The public debt structure depends on the economic conditions within the country. Quite big role is played by the domestic financial market, or to be more precise, by its development and efficiency. Well-developed financial market allows government to attract more funds from the internal creditors and benefit from better loan conditions. Moreover, the internal borrowings are mostly provided in national currency that allows to fully avoid the currency risk.

As most other countries, which are on the stage of developing, Ukraine has a financial market that cannot be called very stable and well-grown. Thus, the less money the government attracts via government bonds on the internal market, the more funds it should attract via external borrowing to fulfill its needs in covering state budget deficit and financing its projects. Moreover, the internal borrowing also requires the high level of trust to authorities from residents – the more it is, the more economic entities will be ready to lend, and the more funds will be attracted on the internal market. In this aspect Ukraine also has some difficulties because a trust to the government still remains on the quite low level.

The degree of sensitiveness to the currency shocks can be also evaluated by studying the debt's structure in terms of currencies. As of the end of 2021 year the public debt of Ukraine has the following structure (Figure 2.2): 36,78% – Ukrainian hryvnia, 34,44% –

US dollar, 14,81% – SDR, 13,45% – Euro, 0,51% – Japanese yen, 0,02% – British pound.
Thus, 63,22% of public debt is in the foreign currency and 36,78% is in national one.

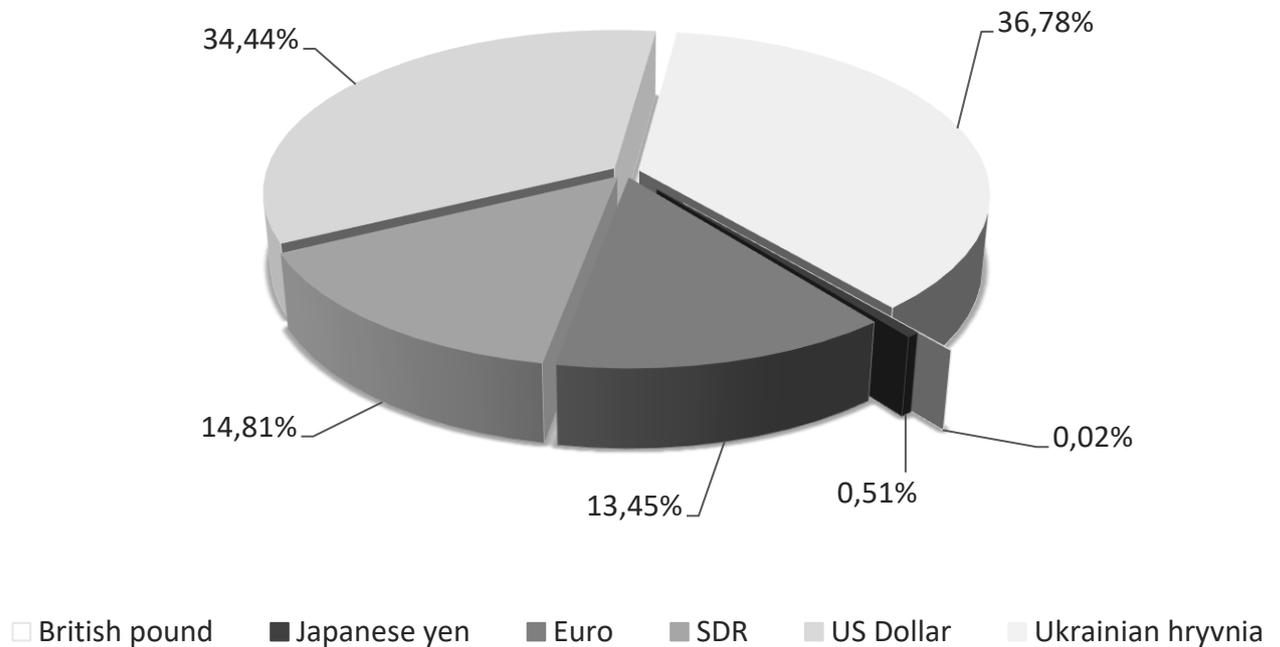


Figure 2.2 – The structure of Ukrainian public debt by currency as of 2021 year
Source: created based on Ukrainian Ministry of Finance data [50]

The study of International Monetary Fund states that the share of public debt in foreign currency should not exceed 60% of total public debt. If it does, then the sensitivity to the exchange rates fluctuations is too high and, consequently, risks are higher [14]. As in Ukraine this indicator equals to 63,22%, the sensitivity of Ukrainian economy to the fluctuations of currency exchange rates can be considered as higher than it is desired to be. With intention to reduce the risk of currency, the logic decision in such situation would be to design a strategy that will increase the share of internal debt and reduce the external one, and make the economy less jeopardized.

As follows, it is quite important for every country to develop its internal security market in order to increase the share of internal debt. In the Table 2.2 it is shown the dynamics of funds that has been attracted by Ukrainian authorities via internal government bonds during last 10 years.

Table 2.2 The dynamics of internal government bonds for 2011-2021 years

	Total public debt, Billion UAH	Funds, attracted via Internal Government Bonds, Billion UAH	Funds, attracted via Internal Government Bonds, %
2011	473,1	158,3	33,5 %
2012	515,5	186,4	36,2 %
2013	584,1	252,5	43,2 %
2014	1 100,6	458,1	41,6 %
2015	1 572,2	505,3	32,1 %
2016	1 929,8	668,1	34,6 %
2017	2 141,7	751,0	35,1 %
2018	2 168,6	758,8	35,0 %
2019	1 998,3	827,4	41,4 %
2020	2 551,9	998,7	39,1 %
2021	2 671,8	1 060,7	39,7 %

Source: created based on Ukrainian Ministry of Finance data [45]

Despite that the absolute values of internal government bonds have a trend of constant increasing, the relative values, though, have been fluctuating during all observed period of time. By looking at the dynamics it can be noticed that the share of funds, attracted via internal government bonds, in the total public debt is increasing from year to year but then decreases as the crisis comes. Thus, this indicator was increasing from 2011 to 2014 year (from 33,5% to 41,6% respectively) and from 2015 to 2019 year (from 32,1% to 41,4% respectively) but has sharply decreased in 2015 and 2020 years. Despite this, in general, the share of funds received by Ukraine via internal government bonds increases. Such trend, undoubtedly, helps to reduce sensitivity of Ukrainian economy from the currency exchange rates and has a positive impact on its stability.

In addition, it is reasonable to compare interest rates of external and internal debts. The share of internal government bonds in total internal debt of Ukraine in 2021 year equals to 99,8%, so the bonds yield can be considered as the internal debt cost. According to the National Bank of Ukraine, in 2021 year the average weighted yield of bonds issued in hryvnia was 11,34%, while the yield of those issued in US dollar and Euro was 3,75% and 2,45% respectively [19]. At the same time, Ukraine issues Eurobonds and sells it on

the external market with the interest rate of 8-12% that is in several times higher than the internal borrowing. An average cost of credits on the external market from international institutions and foreign governments is approximately the same – it reaches 10%. Nevertheless, there are some exceptions too. For example, International Monetary Fund gives credits with quite low cost – the average interest rate is 3% [29].

Overall, the public debt became a regular economic phenomenon that serves to support and stimulate the country's economy and development, but its amount has the certain boundaries which indicate about the state of affairs in the country regarding public debt. One of the indicators which shows the degree of debt's burden on the economy is debt to GDP ratio. It shows the country's solvency in the future and its ability to provide debt servicing. The highest acceptable boundary for it is considered to be equal to 80%, according to the International Bank for Reconstruction and Development, or 77%, according to the World Bank [1]. The dynamics of debt to GDP ratio from 1997 to 2021 year for Ukraine is shown on the Figure 2.3.

As it can be seen on the Figure 2.3, the debt to GDP ratio has been exceeding the upper acceptable value in 2 years in total according to the World Bank's boundary and in 1 year in total according to the boundary of the International Bank for Reconstruction and Development. In 2021 year the public debt of Ukraine was 97 126 mln USD, while the GDP was 199 622 mln USD, thus, the debt equals to 48,9% of GDP. This is the lowest value of this ratio during the last 8 years but it is still higher than before crisis in 2014.

The highest this ratio was in 2016 year when the public debt exceeded the critical point and reached 81% of Ukrainian GDP. Such indicators are characterized by the significant burden on the economy and jeopardizes the country's solvency. Overall, sharp increases of debt to GDP ratio that have been continuing from 2008 to 2010 and from 2014 to 2016 can be explained by the economic crisis in Ukraine, caused by war. The devaluation of hryvnia together with a constantly growing needs in covering the state budget deficit, as well as constantly growing debt service costs, led to a situation when the growth rate of public debt has been exceeding the growth rate of country's GDP during several years. This initiated an increase of debt to GDP ratio and led to reaching its maximum.

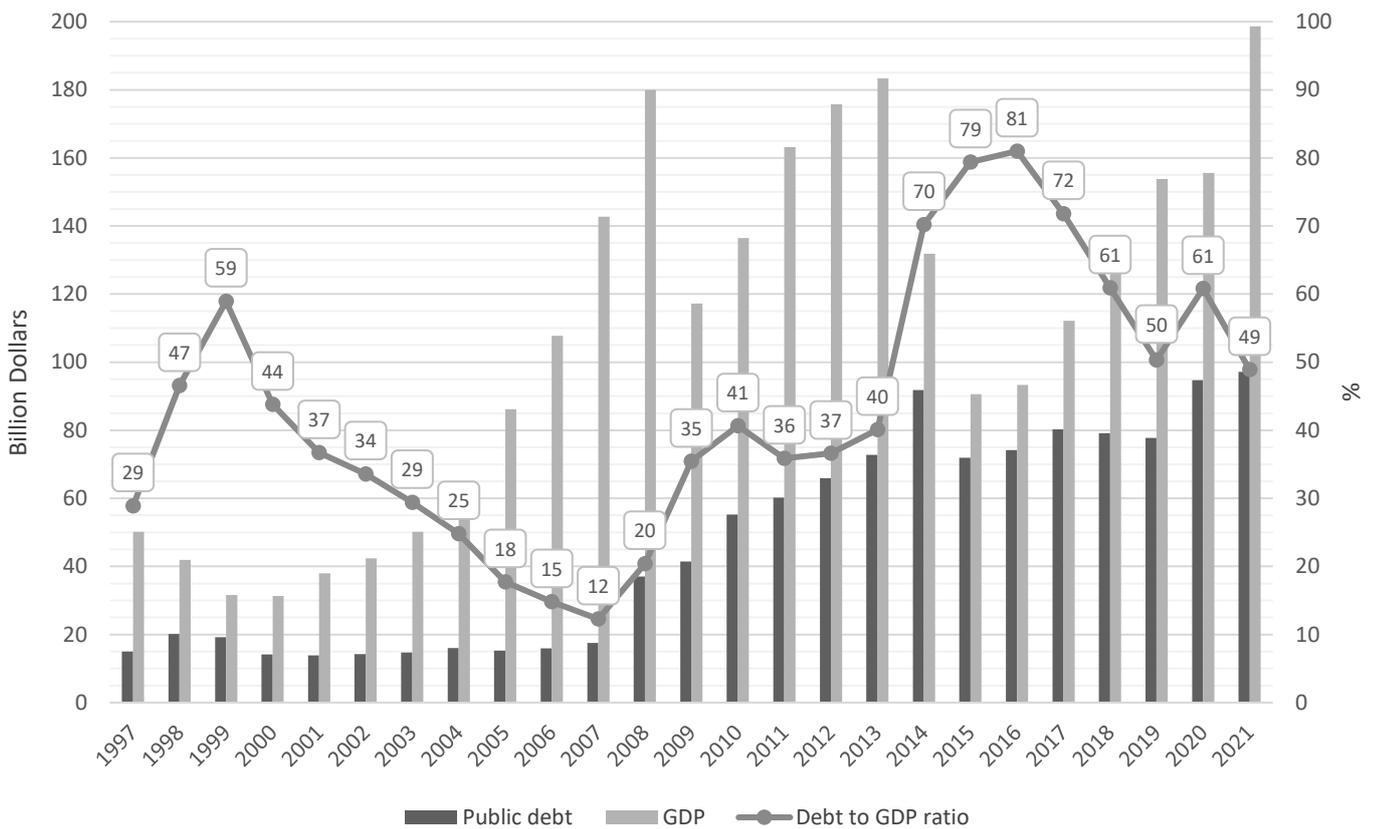


Figure 2.3 – The dynamics of public debt, GDP and debt to GDP ratio

Source: created based on Ukrainian Ministry of Finance data [45]

Nevertheless, starting from 2016 year the debt to GDP ratio has a positive dynamic. Thus, comparing to 2016, in 2021 year this indicator became lower on 32,1%, in other words, decreased 1,7 times. Despite the limits set for the debt to GDP ratio by international institutions, from 2010 year Ukrainian government has set aw its desirable level as 60% of GDP [56]. On the Figure 2.3 it is shown that the debt to GDP ratio was lower than the set level just during first 3 years after an appropriate law validation. During all the time after 2013 the ratio given has been higher than 60% and became lower just in 2019 and 2021 years.

To sum up, last few years overall demonstrate a positive tendency – an internal security market is slowly, but developing, that allows the government to attract more funds on the internal market over years. However, despite this, the debt's sensitiveness from currency shocks still remains on the quite high level and, moreover, there is a chronic state budget deficit in Ukraine that forces authorities to take credits on the external market, where both interest rates and currency risk are higher.

As it was already said, the debt regulation strategy is based not just on the debt to GDP ratio, other debt security indicators are no less important. The dynamic of several indicators is shown on the Figure 2.4:

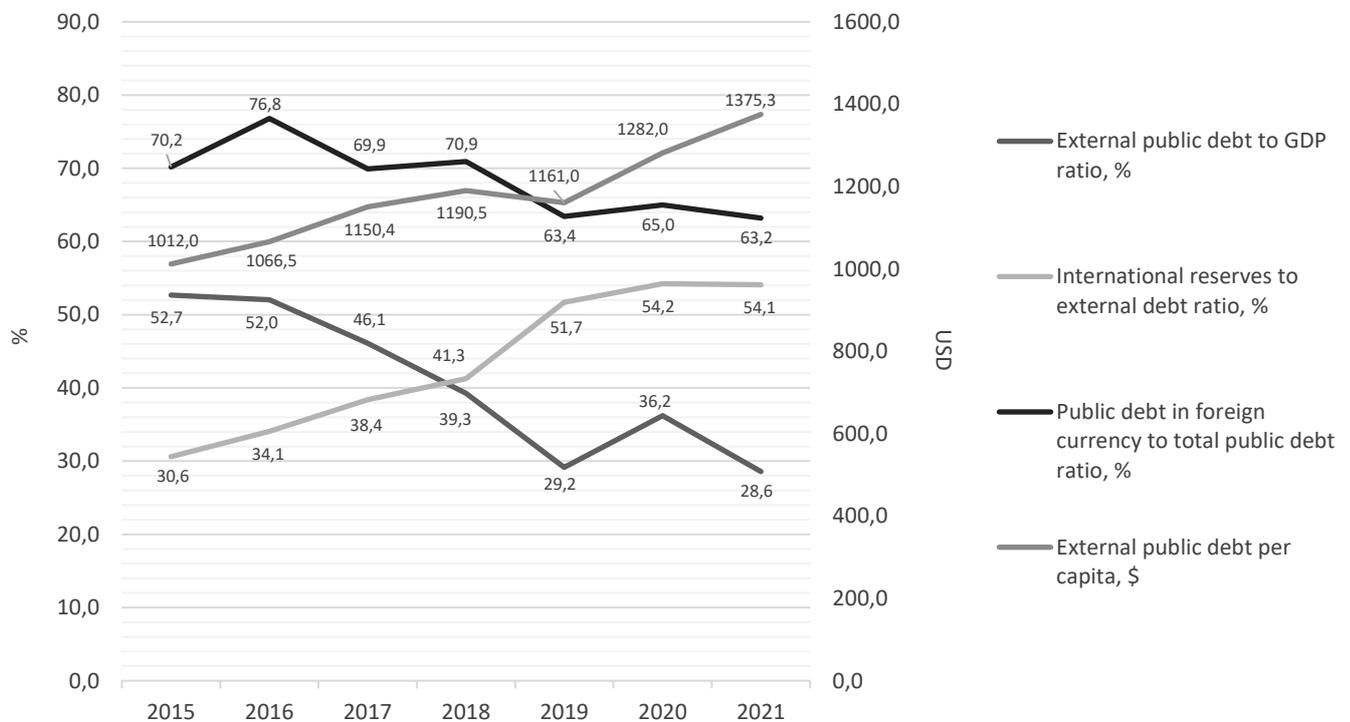


Figure 2.4 – The dynamics of debt security indicators for 2015-2021 years

Source: created based on Ukrainian Ministry of Finance data [3],[18],[45],[50],[52],[57],[59],[60]

The first indicator, external public debt to GDP ratio, characterizes the degree of debt bondage of the economy from the external financing. The critical value for this indicator is on the level of 50% and, as it can be seen on the Figure 2.4, this plank was exceeded twice: in 2015 and 2016 years when the ratio was 52,7% and 52% respectively. Nevertheless, the trend of this ratio in last years indicates about an improvement – it has reduced from 46,1% to 28,6% over 4 years, thus, today this ratio in Ukraine is in satisfactory boundaries.

Second indicator, international reserves to external debt ratio, shows if the country has an opportunity to use its reserves for providing a public debt repayment and what share of debt can be covered by these reserves. The World Bank defines the critical level for this ratio as 80-100%, while the International Monetary Fund set it as 50% and European union as 40%. The statistical data (Figure 2.4) shows that the value of this

indicator in Ukraine rises from year to year and in last 3 years it exceeds the minimal satisfactory level set by International Monetary Fund.

Public debt in foreign currency to total public debt ratio serves as an indicator that can help to obtain an understanding of how sensitive the country's economy is to the different shocks on the currency market. The critical value for it is 60% and, as it is represented on the Figure 2.4, in Ukraine this ratio exceeds the higher boundary within all the period observed that indicates about higher level of risk and economy's weakness.

An external public debt per capita usually is used to estimate the country's dependency from other economies. The normal its value equals to \$200, that is much more lower than the Ukrainian indicators – \$1012,0 in 2015 and \$1375,3 in 2021. An every-year increase of this indicator means the slow accumulation of debt. To evaluate today's state of affairs in Ukraine, all indicators can be checked on the remoteness from normal and critical values (Table 2.3):

Table 2.3 The World Bank system of debt security indicators as of 2021 year

	Ukraine	Optimal value	Satisfactory value	Unsatisfactory value	Dangerous value	Critical value
Total public debt to GDP ratio, %	49	20	30	40	50	60
External debt to GDP ratio, %	29	40	45	55	60	70
Weighted average yield of government securities on the primary market, %	12	4	5	7	9	11
Index EMBI+Ukraine	651*	200	300	500	700	1000
International reserves to external debt ratio, %	54	50	45	41	36	20

Source: calculated based on Ukrainian Ministry of Finance and World Bank data [12],[32],[40],[45],[52]

* – *The value as of 2020 year*

As it can be seen, the total public debt to GDP ratio as of 2021 year equals to 49%, while the dangerous zone starts from 50% (the boundary given is estimated by the World Bank as for developing countries to the row of which Ukraine belongs to). It indicates about high burden, caused on the Ukrainian economy by debt. An index EMBI+ is almost in the dangerous zone too – it equals to 651, that is closer to the upper boundary of zone in which it is rather than to lower one. The weighted average yield of government securities on the primary market exceeds the critical value on 1%. Such rates talk about a high level of economic instability and too high inflation in the country.

To sum up, 3 out of 5 indicators have unsatisfactory values (total public debt to GDP ratio, weighted average yield of government securities on the primary market, index EMBI+ Ukraine). 1 out of 5 barely remains in the optional zone (international reserves to external debt ratio) and only 1 indicator stands firmly in the green (optimal) zone (external debt to GDP ratio).

The debt servicing and repayment costs is also an important indicator. Its trend can be seen on the Figure 2.5:

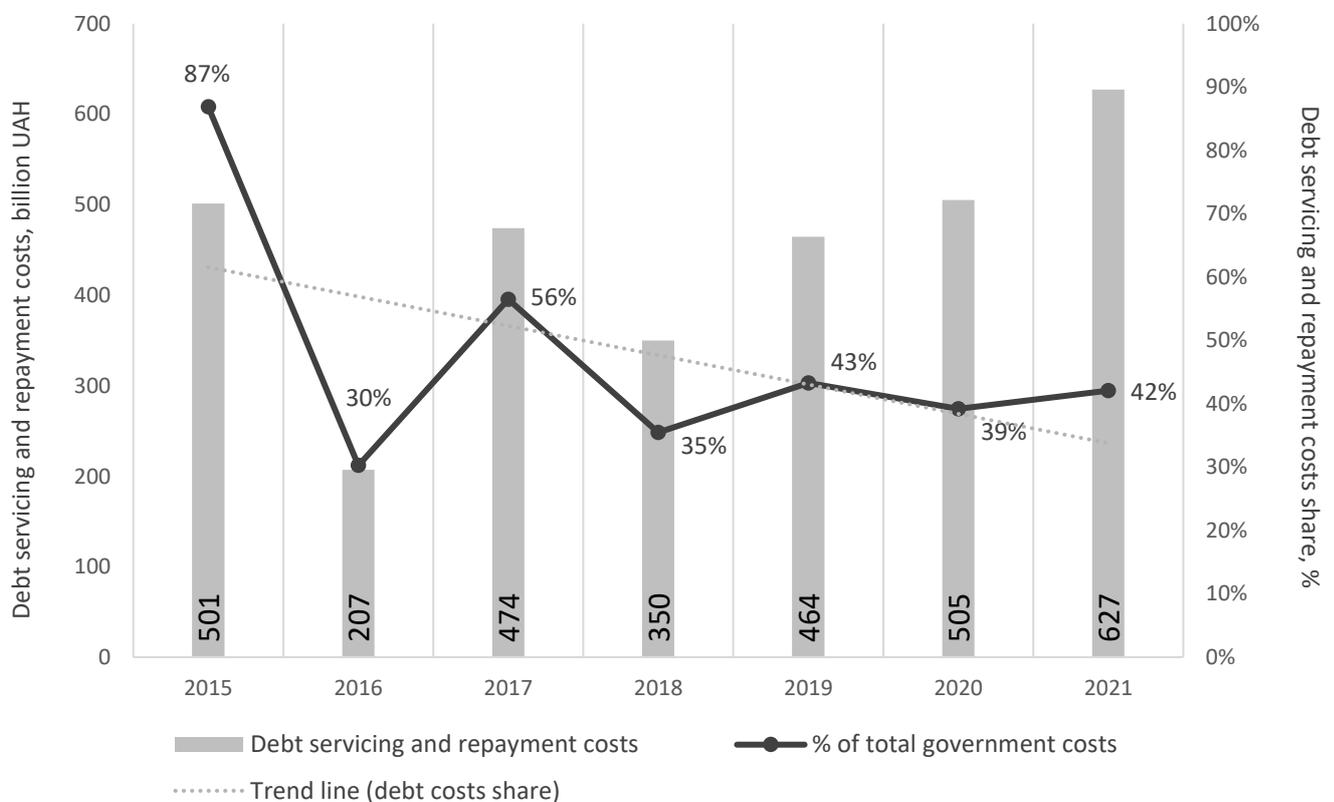


Figure 2.5 – Debt servicing and repayment costs dynamics for 2015-2021 years

Source: created based on Ukrainian Ministry of Finance data [44],[46],[47],[48],[49]

The value of these costs is very important to the country's economy as they are the part of the debt burden. An overall trend indicates that the government costs on providing debt servicing and its repayment raise over year. Nevertheless, to the better understanding of how the value of this indicator influences on the economy, the relative values have been calculated. The debt servicing and repayment costs share in the total government costs shows that the its burden has decreased in recent years. Such dynamics has positive impact on the economy and the preservation of this trend should become one of the core tasks in the process of designing further public debt regulation strategy.

While designing this strategy and taking new liabilities, those charged ones should take into account all future servicing payments that the country should provide according to the existed liabilities. It has to be done in order to maximize the equality of these payments in future years and smooth the possible spikes. Such approach allows to reduce the negative consequences which can occur because of the high debt burden in a certain years caused by the sharp increase of servicing payments.

2.2 Modeling the Ukrainian public debt dependency from key factors with the use of econometric tools

Very important aspect of designing an effective debt regulation strategy is the determination process of key factors which have impact on debt's forming and its accumulation. The correct selection of these factors can give an opportunity to create an efficient influencing mechanism not only on the public debt itself, but also on those core factors, which cause its emergence and dynamics. An understanding of linkages between phenomenons allows to start solving the problem from the very beginning and ensure the positive trend of debt indicators in the country by designing an effective and competent regulation strategy.

With the help of the model given it was studied the strength and direction of different factors which have significant impact on the Ukrainian public debt. The total public debt indicator has been chosen as the dependent variable. The list of variables and their description is provided in the Table 2.4:

Table 2.4 The list of variables included in the model

Dependent variable				
<i>Name</i>	<i>Name in the study</i>	<i>Units</i>	<i>Frequency</i>	<i>Number of observations</i>
Total Ukrainian public debt	TD_USD	Billion \$	yearly data	31 (1991-2021)
Independent variables				
State budget deficit	DEFICIT	% of GDP	yearly data	31 (1991-2021)
	Hypothesis: the volume of state budget deficit has positive correlation with the public debt. The more the deficit is, the more funds the country requires to cover it and, consequently, the more will be the public debt. This variable represents the difference between the government spendings and revenues as the percentage of GDP in the corresponding year.			
Excess of export over import	SALDO	Billion \$	yearly data	31 (1991-2021)
	Hypothesis: the excess of export over import is positively correlated with the public debt. The variable given represents the lack of funds that are needed for trading balance to be equal to 0. In case on Ukraine almost in all observed years the import exceeds export, thus, SALDO represents the difference between import and export as the percentage of GDP in the corresponding year.			
Corruption index	CPI	dimensionless	yearly data	24 (1998-2021)
	Hypothesis: the corruption prevalence is positively correlated to the amount of public debt. The higher the corruption is, the less funds get to its destination, less profitable investments the country receives and, thus, the more credited funds it requires for the future development.			

Source: based on data [3],[30],[33],[35],[45]

On the very beginning of the study there has been chosen a row of possible factors, which could have a significant effect on the public debt trend. During the modeling the number of factors has been reduced to 3. It was made to make the model representative according to the econometrics rule that states that the number of factors has to be established due to the rule of thumb – at least 10 observations on 1 independent variable. The level of trust for the regression is 5%.

Below there is a general equation that represents the Ukrainian public debt dependency from the factors chosen: budget deficit, excess of export over import and corruption index:

$$TD_USD = C(1) + C(2)*DEFICIT + C(3)*LOG(SALDO) + C(4)*CPI$$

Because the data of SALDO is in the absolute values and, thus, is volatile, this variable has been logged with intention to smooth the fluctuations and make the regression results better. An overall model view is shown on the Figure 2.6:

Dependent Variable: TD_USD
Method: Least Squares
Date: 04/14/22 Time: 20:05
Sample (adjusted): 1998 2020
Included observations: 16 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-121.6341	44.54709	-2.730460	0.0183
DEFICIT	10.02932	2.853185	3.515130	0.0043
LOG(SALDO)	13.72344	5.208582	2.634774	0.0218
CPI	4.627044	1.460974	3.167094	0.0081

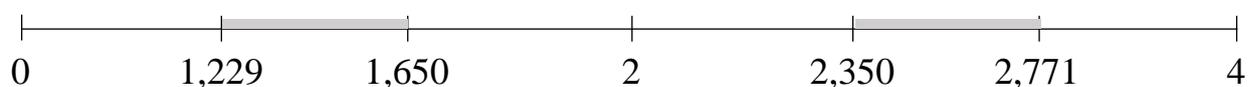
R-squared	0.641430	Mean dependent var	56.17598
Adjusted R-squared	0.551788	S.D. dependent var	25.60273
S.E. of regression	17.14069	Akaike info criterion	8.733105
Sum squared resid	3525.638	Schwarz criterion	8.926252
Log likelihood	-65.86484	Hannan-Quinn criter.	8.742996
F-statistic	7.155425	Durbin-Watson stat	1.869452
Prob(F-statistic)	0.005185		

Figure 2.6 – Model: the public debt dependency from the factors selected

Source: made by author in the EViews software

Checking the assumption №1 (H_0 – The mathematical expectation of a random variable equals to zero). The coefficient of cross section is included in the model ($C = -121,6341$) and is significant ($\text{Prob.} = 0,0183 < 0,05$) that shows that the assumption given is true and the H_0 can be accepted.

Checking the assumption №2 (H_0 – Autocorrelation of random variables is absent). Below there is a scale that contains autocorrelation zones. Zones' boundaries were calculated with the help of Durbin-Watson table of critical points which are used to define the presence or absents of the first order autocorrelation [7]:



Autocorrelation zones explanation:

- (0 ; 1,229) – the positive autocorrelation is present;
 (1,229 ; 1,650) and (2,350 ; 2,771) – uncertainty;
 (1,650 ; 2,350) – the autocorrelation is absent;
 (2,771 ; 4) – the negative autocorrelation is present.

The Durbin-Watson statistics in the regression built equals to 1,869 (Figure 2.6). This number corresponds to the (1,650 ; 2,350) zone which is a zone where the first order autocorrelation is absent. So, the assumption is true and H_0 can be accepted.

Checking the assumption №3 (H_0 – Homoskedasticity of random variables). To check this assumption the White's test has been made. On the Figure 2.7 it can be seen that the heteroskedasticity problem is absent – Chi-Squares are $> 0,05$ (insignificant) as well as the Fisher's criteria ($\text{Prob.F} = 0,37 > 0,05$).

Heteroskedasticity Test: White

F-statistic	1.338127	Prob. F(9,6)	0.3733
Obs*R-squared	10.67942	Prob. Chi-Square(9)	0.2983
Scaled explained SS	3.513486	Prob. Chi-Square(9)	0.9404

Test Equation:

Dependent Variable: RESID^2

Method: Least Squares

Date: 04/14/22 Time: 20:06

Sample: 1998 2020

Included observations: 16

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-10828.06	10642.19	-1.017465	0.3482
DEFICIT^2	-63.52304	67.01839	-0.947845	0.3798
DEFICIT*LOG(SALDO)	-151.7343	126.3966	-1.200462	0.2752
DEFICIT*CPI	-45.23833	59.47553	-0.760621	0.4757
DEFICIT	1736.281	2108.544	0.823450	0.4417
LOG(SALDO)^2	-154.2413	142.5558	-1.081972	0.3208
LOG(SALDO)*CPI	-106.7416	105.4304	-1.012436	0.3504
LOG(SALDO)	3676.560	3369.202	1.091226	0.3170
CPI^2	-4.018196	9.034866	-0.444743	0.6721
CPI	484.0474	511.9076	0.945576	0.3809

R-squared	0.667464	Mean dependent var	220.3524
Adjusted R-squared	0.168659	S.D. dependent var	246.1394
S.E. of regression	224.4247	Akaike info criterion	13.93413
Sum squared resid	302198.7	Schwarz criterion	14.41700
Log likelihood	-101.4730	Hannan-Quinn criter.	13.95886
F-statistic	1.338127	Durbin-Watson stat	2.962329
Prob(F-statistic)	0.373305		

Figure 2.7 – The White's test results

Source: made by author in the EViews software

So, the H_0 cannot be rejected – the assumption is true that means that the problem of heteroskedasticity is absent (the presence of different dispersion within residuals is considered to be negative characteristics of the model).

Checking the assumption №4 (H_0 – There is no relationship between the independent variable and the random variable). To check the presence or absents the autocorrelation of other orders (differed from first one) the Breusch-Godfrey test has been made. The results can be seen the Figure 2.8:

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.056328	Prob. F(10,2)	0.9995
Obs*R-squared	3.516005	Prob. Chi-Square(10)	0.9666

Test Equation:
 Dependent Variable: RESID
 Method: Least Squares
 Date: 04/14/22 Time: 20:08
 Sample: 1998 2020
 Included observations: 16
 Presample and interior missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	814.9690	732.6062	1.112424	0.3817
DEFICIT	-0.016700	18.90120	-0.000884	0.9994
LOG(SALDO)	7.729775	19.97596	0.386954	0.7361
CPI	-29.73535	25.73818	-1.155301	0.3673
RESID(-1)	2.508958	2.803339	0.894989	0.4652
RESID(-2)	2.788316	2.156138	1.293199	0.3252
RESID(-3)	2.658312	2.396112	1.109427	0.3828
RESID(-4)	2.092246	1.946259	1.075009	0.3948
RESID(-5)	1.987247	2.060359	0.964515	0.4366
RESID(-6)	3.134736	2.513473	1.247173	0.3386
RESID(-7)	1.237914	2.035096	0.608283	0.6049
RESID(-8)	-0.446206	1.305469	-0.341797	0.7651
RESID(-9)	1.294534	2.045560	0.632851	0.5915
RESID(-10)	0.781739	2.112015	0.370139	0.7468

R-squared	0.219750	Mean dependent var	2.13E-14
Adjusted R-squared	-4.851873	S.D. dependent var	15.33110
S.E. of regression	37.08691	Akaike info criterion	9.734964
Sum squared resid	2750.878	Schwarz criterion	10.41098
Log likelihood	-63.87971	Hannan-Quinn criter.	9.769581
F-statistic	0.043329	Durbin-Watson stat	0.576904
Prob(F-statistic)	0.999947		

Figure 2.8 – The Breusch-Godfrey’s test results

Source: made by author in the EViews software

The coefficients of all orders are insignificant ($> 0,05$) as well as the Fisher’s criteria (Prob.F = 0,9995 $> 0,05$) that shows that the autocorrelation of all orders is absent. That is why the H_0 is accepted, and the assumption is considered as true.

Checking the assumption №6 (H_0 – The random variable has a normal distribution). The assumption given was checked with the help of Jarque-Bera's test which estimates the compliance of the distribution of residuals with the law of normal distribution. The results are on the Figure 2.9. According to the p-value that equals to 0,739 ($> 0,05$) the conclusion can be made that the residuals have normal distribution, so the H_0 can be accepted and the assumption is true.

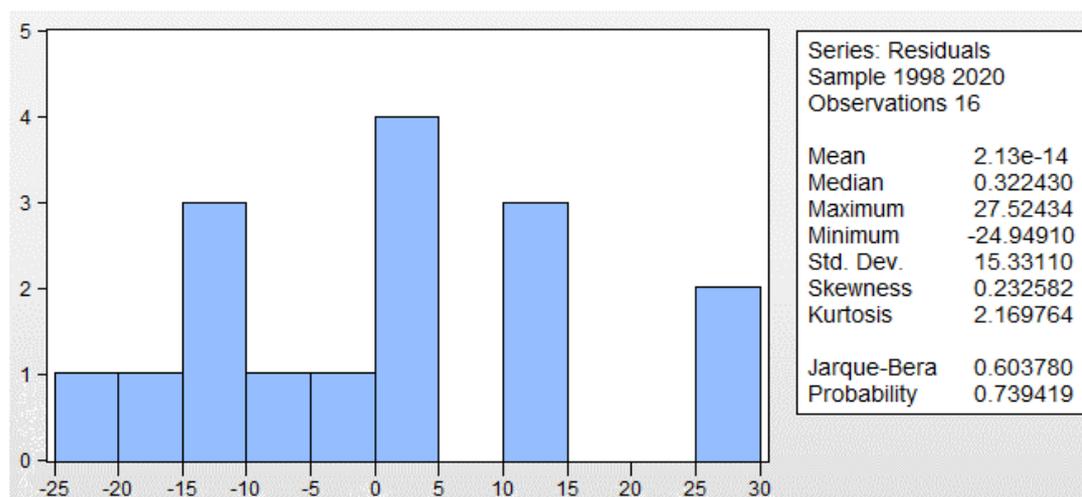


Figure 2.9 – The Jarque-Bera's test results

Source: made by author in the EViews software

Modeling results:

So, the final equation that represents the Ukrainian public debt dependency from such factors as state budget deficit, excess of export over import and corruption is the following:

$$TD_USD = -121.634 + 10.029*DEFICIT + 13.723*LOG(SALDO) + 4.627*CPI + \varepsilon_i$$

The interpretation of the relationships between dependent and independent variables:

1. TD_USD dependency from DEFICIT. C_2 coefficient is positive, so the hypothesis made in the very beginning is true because the correlation is positive – if the state budget deficit rises on 1 percentage point, then the public debt rises on 10 billion \$.

2. TD_USD dependency from LOG(SALDO). A coefficient before this independent variable (C_3) is positive, so the hypothesis, that has been made in the very beginning of

the research, is true, because the correlation is positive – if the saldo rises on 1% then public debt rises on 13,72 billion \$.

3. TD_USD dependency from CPI. C_4 coefficient is positive, so the hypothesis made in the very beginning is true because the correlation is positive – if the corruption level rises on 1, then the public debt rises on 4,63 billion \$.

The model given reveals how the Ukrainian public debt depends on the row of factors. The tests made and other calculations have approved all classic econometric assumptions that indicates about model's representativeness. Overall, the changes in the public debt are explained by model on 64% (Figure 2.6). 36% can be explained by other factors that have not been included in the model.

To sum up, the debt regulation strategy should be designed very cautiously and should ensure a providing of debt repayment and interest payments, the risks and costs reduction and the structure optimality assurance. As of 2021 year, the public debt of Ukraine equals to 2 671 827,6 million UAH, that is 48,9% of GDP (debt to GDP ratio). Such level corresponds to the zone of acceptable values, because it is lower than the higher boundary set (60%). Overall, 49% of the Ukrainian public debt is an external public debt; 40% – internal public debt; 10% – guaranteed external public debt; 2% – guaranteed internal public debt.

The main disadvantages of Ukrainian public debt are the following. Firstly, a share of external public debt is quite high, that is why there is a funds outflow from Ukrainian economy in the form of interest rate payments. Secondly, 63,22% of total public debt is on the foreign currency, while the higher burden is considered to be equal to 60%, that makes the Ukrainian economy very sensitive to the exchange rate fluctuations and implies high risk. However, comparing with 2011 year, the funds, attracted via internal government bonds in Ukraine have raised from 33,5% to 39,7% of total public debt. It indicates that the internal security market has a positive trend in its development. In turn, the internal security market development implies reducing such negative aspects of external debt as funds outflow and currency risk. Moreover, an internal debt has lower cost – average yield of internal government bonds issued in US dollar and Euro was

3,75% and 2,45% respectively, while on external market Ukraine issues Eurobonds with the interest rate of 8-12%.

To design an effective debt regulation strategy it is important to study the dynamics of country's public debt and its dependency from different factors. According to the econometrics model built, if the state budget deficit rises on 1 percentage point, then the public debt rises on 10 billion \$; if the excess of export over import rises on 1% then the public debt rises on 13,72 billion \$; if the corruption level rises on 1 position, then the public debt rises on 4,63 billion \$. An understanding of factors weight and significance can help to determine core points of the strategy and increase its efficiency.

Consequently, the results received may be used in the process of public debt regulation strategy. Taking into account at least the bigger part of important factors, and their weight in the impact, can help to increase the efficiency of a strategy designed and significantly reduce the debt burden on the country. For example, according to the model created, the most significant factors among chosen ones are the budget deficit and the excess of export over import. It means that while creating the strategy, those charged ones should design a plan which would have a positive impact on these factors (reducing both a deficit and the difference between import and export) that would automatically influence on the public debt in a positive way in the future years.

CHAPTER 3 MAIN FACTORS INFLUENCING ON PUBLIC DEBT OF UKRAINE AND WAYS OF IMPROVING THE UKRAINIAN DEBT STRATEGY

3.1 The public debt system interrelationships modeling

A high debt burden jeopardizes the stability of the country's economy, its solvency and, consequently, the wellbeing of the whole population and further development of the country. A competent debt regulation and a well-designed strategy is the issue that relates to each individual, that is why the preliminary studying of debt's phenomenon and influencing factors on it is very important part in the process of strategy designing. In case of insufficient studying or inappropriately processed analysis, the policies implemented may negatively influence on the public debt value, that will increase the debt burden and aggravate the economic conditions.

As it was already stated earlier, a significant influence on the effectiveness of public debt regulation strategy is caused by the process of searching and determining the core factors which have an impact on the public debt and by which its dynamics is mostly defined by. An understanding of how all these factors influence on the public debt dynamics, and how every single part of the system is connected with other parts, may positively affect on the created policies effectiveness and reduce the risks of unexpected negative consequences appearance over time.

The model of public debt system interrelationships gives an opportunity to obtain a better understanding of what the public debt dynamics is dependent from, allows to study different possible scenarios, both in the aspect of past and the future, check the sensitiveness of public debt to the row of different factors and, in addition, make a prediction of how the policy designed will influence on the whole system in general and the public debt dynamics in particular.

In terms of model limitations it should be noted, firstly, that the system modeling approach implies the creation of simplified version of the reality and does not include a

comprehensive set of parts of the real-life system. Secondly, the model given represents only non-guaranteed public debt dynamics (both external and internal). The guaranteed public debt is not included in the system as its representation requires a separate sub-model and additional researches.

The casual loop diagram (CLD) of the model (Appendix A) represents all variables, included in the model, and shows their linkages with each other within the model given. The description of all variables can be found in the Appendix B. Overall, there are 5 loops in the model, all of them are shown in the CLD. Also, among these 5 loops, 3 are reinforcing (when an increase in variable's value causes its increase over year) and 2 are balancing (when an increase in variable's value causes its decrease over year).

Balancing loop 1 (B1): Internal debt body – Internal debt servicing and repayment – Internal debt body. It is a minor loop, that represents the interrelationship between the stock (Internal debt body) and its outflow (Internal debt servicing and repayment). These two variables, logically, have a direct dependency – the more is the value of the Internal debt body, the more are Internal debt servicing and repayment costs that should be paid as debt servicing and repayment. An increase in the outflow from the stock makes the value of the stock lower, that corresponds to the balancing loops notion and allows to define B1 loop as balancing.

Balancing loop 2 (B2): External debt body – External debt servicing and repayment – External debt body. It is also a minor loop that has the same principle of working as the B1 loop. The only difference is that the B2 loop is related to the External debt body and its interrelationship with an outflow. In this way, these two variables also have a direct dependency – the more is the value of External debt body, the higher are External debt servicing and repayment costs that should be paid as debt servicing and repayment. This loop is defined as balancing as well.

Reinforcing loop 1 (R1): External debt body – External debt servicing and repayment – Debt servicing costs – Budget expenditure – Budget deficit – New external loans – External debt body. This loop represents the dependency of External debt body volume in the future from itself in the current period. The system implies that higher value of External debt body today will contribute to the higher its volume in the future. It can

be explained by the row of direct positive correlations between the elements of this loop. As it was already said, higher value of External debt body implies the higher External debt servicing and repayment expenditure. It, consequently, causes an increase of total Debt servicing costs that, in turn, leads to the higher Budget expenditures and the Budget deficit raising. If the Budget deficit raises, then the government is forced to take more loans, both internal and external, to cover it. As a result – the External debt body increases. Thus, the higher is the value of External debt body, the more it is in the future – such dependency is a characteristic of reinforcing loops, thus, R1 is defined as reinforcing.

Reinforcing loop 2 (R2): Internal debt body – Internal debt servicing and repayment – Debt servicing costs – Budget expenditure – Budget deficit – New internal loans – Internal debt body. This loop works by analogy with the R1 loop, but relates to the Internal debt body, rather than external one, and its impact on its values in the future periods. Thus, the interrelationships in this loop between all elements are also positive, that means that the higher value of Internal debt body will lead to the higher its value afterwards. As the increase of a variable leads to its rising in the future, the loop is also defined as reinforcing.

Reinforcing loop 3 (R3): New internal loans – Internal debt body – Internal debt – Non-guaranteed public debt – Non-guaranteed debt to GDP ratio – External debt interest rate – External debt servicing and repayment – Debt servicing costs – Budget expenditure – Budget deficit – New internal loans. This loop, essentially, is a representation of R1 and R2 combination. R3 loop works by an analogy to R1 and R2 loops, but implies in itself the dependency of total public debt from its value it the past rather than external and internal public debts separately. Therefore, as well as in case of separated external and internal debts, the higher value of total debt in the current period causes its increase in the following periods – this loop is also reinforcing.

The whole system includes 3 variables which are represented in the model as the stocks: Population, External debt body and Internal debt body, each of them has both inflow and outflow (Figure 3.1). These variables have been represented as the stocks because they are predisposed to accumulate over time.

The dynamics of population is defined by an inflow, represented by new-born people, and by outflow, represented as deaths and average net migration rate (the net migration rate is defined as the factor that influences on the outflow, rather than on the inflow, because this indicator is negative for Ukraine). Since the population is the main force that creates goods and services, the GDP in the system is defined by the value of Population stock.

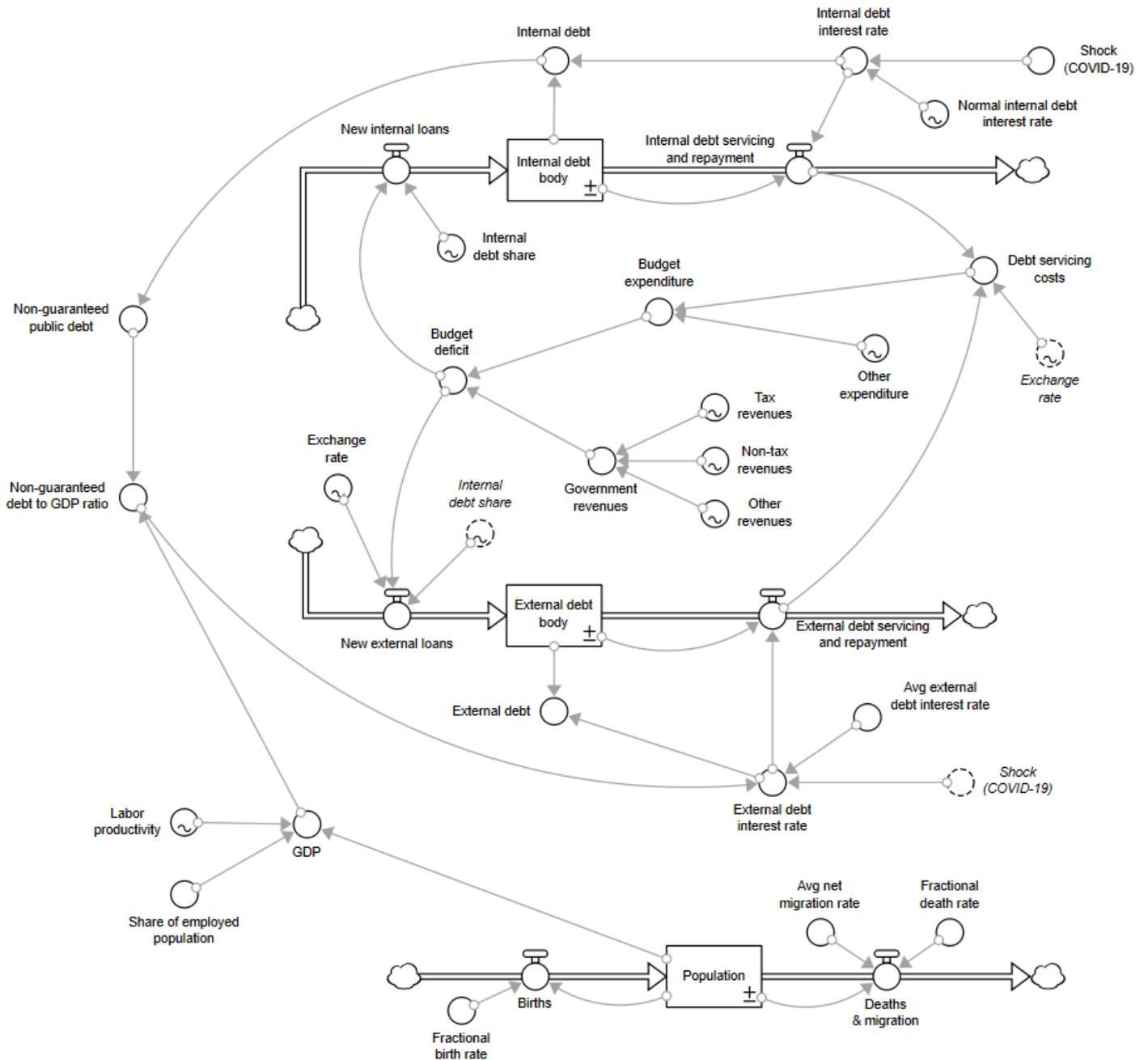


Figure 3.1 – The stock and flow diagram (SFD)

Source: made by author in the Stella Architect software

The system is built in such way that allows to study not only total public debt dynamics, but also dynamics of internal and external public debts separately. The model covers in general 9 years, starting from 2017 and ending in 2025. The values for the last 4 years are predictions of the model. On the Figure 3.2 it is shown the reference modes (historical data) of the key variables and their dynamics, generated by the model.

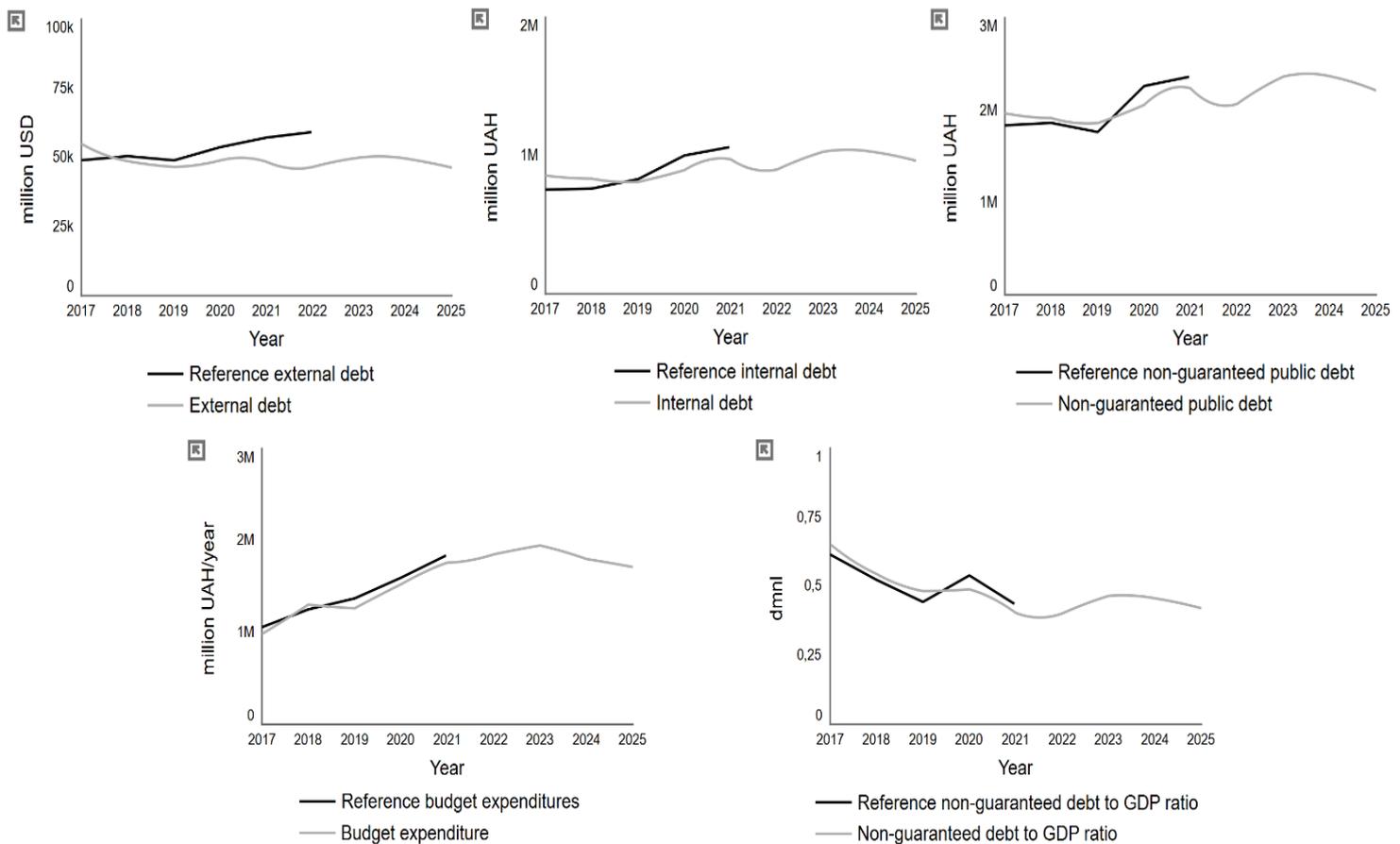


Figure 3.2 – The reference modes and modeling results

Source: made by author in the Stella Architect software

As it can be seen, the model reproduces an overall dynamics of reference modes. On the graphs of External debt, Internal debt and their summarized value (Non-guaranteed public debt) there is an increase that starts in 2019 year. Such behavior is caused by the reinforcing loops, which have been described earlier and one other factor – a shock.

The system is built in a such way, that the value of Non-guaranteed debt to GDP ratio has an impact on the country's economic stability and, consequently, interest rate of the loans and the servicing and repayment costs. The higher is the Non-guaranteed debt

to GDP ratio, the more unstable is country's economy and, because of the higher risks, lenders demand higher interest rates. Thus, the debt volume determines the debt to GDP ratio that, in turn, increases costs on servicing and repayment, total Budget expenditures, Budget deficit and, consequently, the volume of debt.

Not less significant impact on the dynamics of Ukrainian public debt had the COVID-19 shock. This shock hit the economies even of the most developed countries. The world entered the period of uncertainty that caused an increase of interest rates on the external market. In addition, the exchange rate of Ukrainian hryvnia also has been fluctuating, thus, the External debt body, as well as the External debt servicing and repayment, increased. Over time, as the humanity has been getting used to live with COVID, the interest rates started to decrease.

According to the data of Ukrainian Ministry of Economy, the level of shadow economy in the last 10 years, as the percentage of official GDP volume, fluctuates from 36% to 28% [37]. Thus, despite the baseline scenario, it has been made one more scenario, which implies that the level of shadow economy is lower, than it was in fact. To model such scenario, changes have been made in two variables: GDP and Tax revenues. To the formula of GDP it has been added a coefficient, that would increase the value of GDP on 10% within the entire period of time in the model. Changes in Tax revenues imply their increase also on 10% within the entire period of time in the model (Figure 3.3):

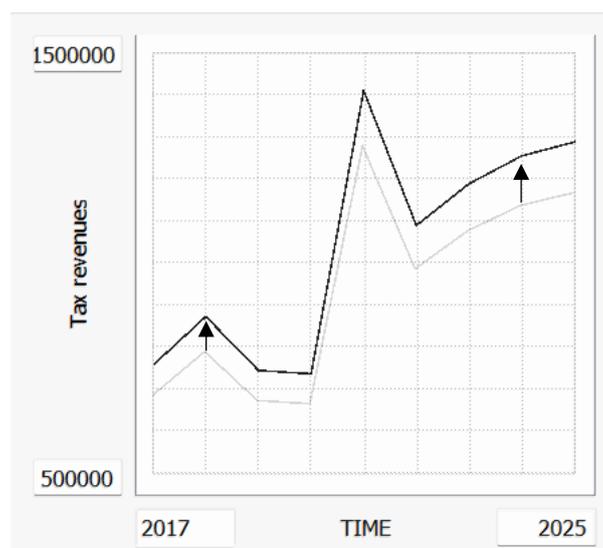


Figure 3.3 – Changes in the Tax revenues due to lower shadow economy level

Source: made by author in the Stella Architect software

On the Figure 3.4 it can be seen the difference of four core variables dynamics in terms of two scenarios:

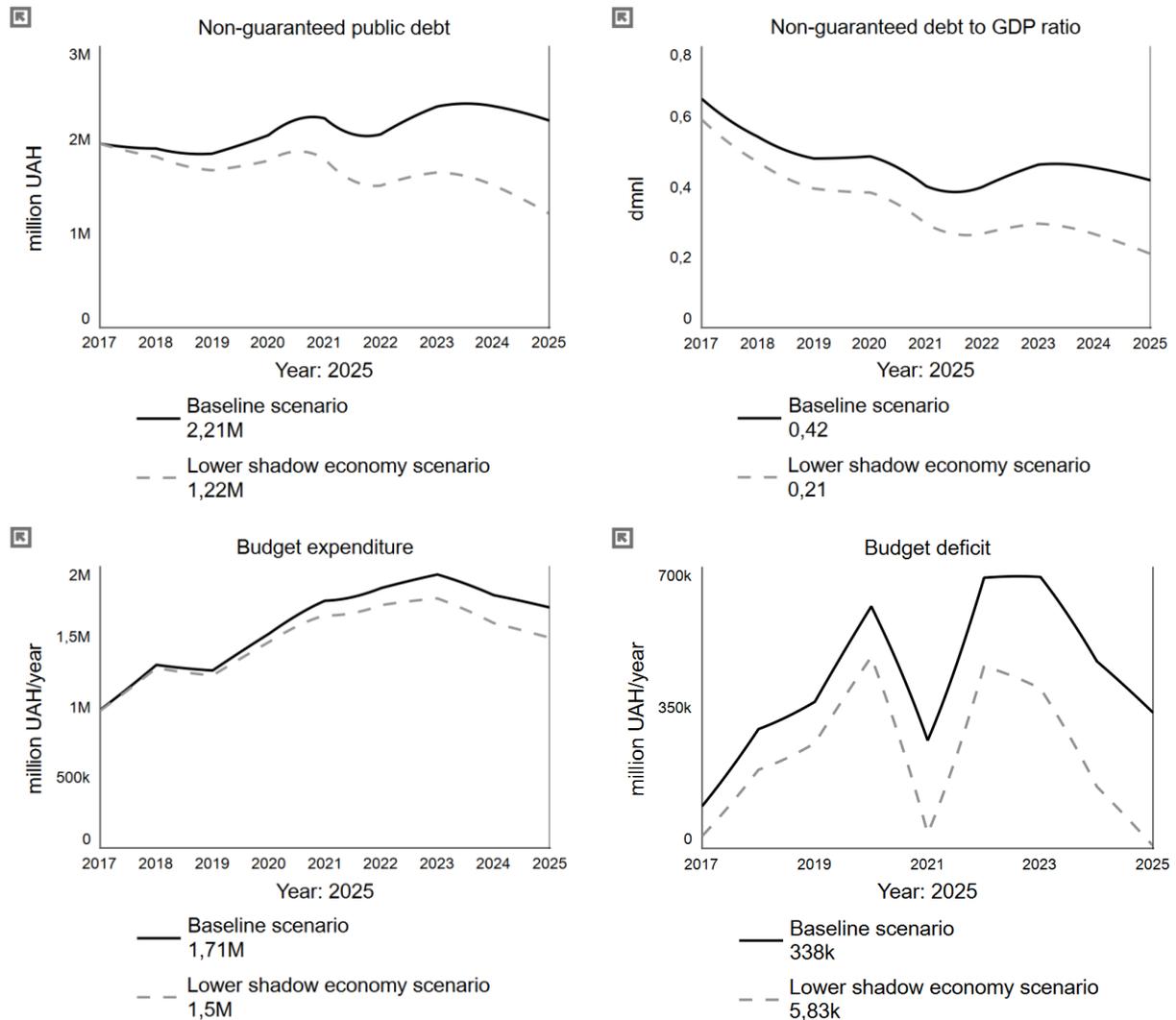


Figure 3.4 – Baseline scenario and Lower shadow economy scenario

Source: made by author in the Stella Architect software

So, if the level of shadow economy in Ukraine was lower, then the GDP would be higher, and the state budget would receive more funds from taxes due to lower level of tax avoidance. As it can be seen on the Figure 3.4, all indicators in case of Lower shadow economy scenario show lower values, than in Baseline scenario, that indicates about an importance of decreasing shortfalls from taxes.

The baseline modeling shows that in the 2025 year the value of Non-guaranteed public debt will be approximately 2 210 000 million UAH, the Non-guaranteed debt to GDP ratio will be 42% and the Budget expenditure will be 1 710 000 million UAH/year.

Overall, according to the results, shown by the model, it can be said, that if the shadow economy was lower and, consequently, both GDP and Tax revenues were higher at least on 10%, then the Non-graduated public debt would decrease on 45% as of 2025 year in comparison to the Baseline scenario (2 210 000 million UAH in Baseline scenario and 1 220 000 million UAH in Lower shadow economy scenario).

Consequently, if the GDP is higher, while the debt itself is lower, the Non-guaranteed debt to GDP ratio would also have lower values – in Lower shadow economy scenario this ratio equals to 21%, in contrast, the Baseline scenario shows the result on the level of 42%, thus, the ratio would become 2 times lower – on 21%. As the share of Non-guaranteed public debt in the total public debt is approximately 88%, then the total debt to GDP ratio in Lower shadow economy scenario would be equal to 24%. Such value of debt to GDP ratio would ensure lower debt burden on the Ukrainian economy, lower dependency from other countries, lower sensitiveness from the exchange rate fluctuations and, as the result, higher stability of Ukrainian economy. Moreover, the Ukrainian economy would not have such high outflow of capital in the form of interest payments, that is also very important to the long-term country's development.

A decrease of Budget expenditure is also logical – as it already has been said, the lower the debt is, the lower are government costs linked with debt – firstly, the body of debt is lower, thus, repayment costs are lower and, secondly, the economy is more stable and interest rates are lower, that also decreases the costs on debt's servicing. Thus, in case of Lower shadow economy scenario, the Budget expenditures would be lower on 210 000 million UAH per year in absolute values and on 12% in relative ones, while the government revenues increase (in comparison to the Baseline scenario) due to the higher income, collected from taxes. These two factors in combination lead to the decrease of Budget deficit value, or even an occurrence of surplus, that puts away the necessity of taking new loans to cover the budget deficit and allows to provide the financing of different government investment programs without someone else's funds attraction.

To sum up, the system dynamics approach and the model built allow to determine how sensitive the system is to the changes in different factors. An analysis provided gives an understanding and provides an explanation of all interrelationships in the system, such

as debt spiral, that lies in the idea of all reinforcing loops in the model. The model shows that one of the most important factors on the public debt dynamics is the budget deficit, that is determined by the government revenues and budget expenditure volumes. Thus, the model done shows that while designing the debt regulation strategy, the government should simultaneously concentrate on designing a policy, that would increase the responsibility of population in the issue of paying taxes.

3.2 Ukrainian debt strategy and ways of its improvement

In the issue of debt strategy development it is important to understand that every economy differs from all others and, thus, each of them requires a unique approach of the public debt regulation. The existence of public debt as it is, is not negative, but an inappropriate its regulation and a lack of an effective both long and short-term strategy can jeopardize the country's economy and lead to deterioration of economic conditions instead of their improvement.

The most sufficient and important thing that have been negatively influencing on Ukrainian public debt during almost all 30 years of independency is the absence of clear and effective long-term strategy that would ensure an effective debt usage and the economy's supporting and development.

In 1991-1994 years Ukrainian debt strategy has been characterized with unsystematic, unreasonable decisions and undeveloped internal security market. The budget deficit financing has been provided via NBU's credit resources attraction [21]. The authorities did not have even a short-term strategy and, thus, appeared an uncontrolled increase of government guarantees for residents' foreign credits. The external public debt started to accumulate and rise.

In 1995-1996 years the internal security market began to form and the government now had an opportunity to finance the state budget deficit by attracting funds via selling internal government bonds on this internal market. Despite this, the external public debt of Ukraine kept going to rise because of numerous external government guarantees and new external loans attraction from international financial organizations [21].

During 1997 and 1998 years the government has been extending the volumes of government bonds which it sold on the internal security market, but the increase in government bonds yield led to the increase of internal public debt. After the crisis of 1998 year during two next years the ability to take funds, both on the internal and external markets, has reduced. Ukraine was not able to service such big debt and that is why the debt restructuring has been provided in terms of internal public debt [21]. The government bonds were replaced with the interest bonds and loan payment period was extended.

After such uncontrolled debt regulation Ukrainian authorities have made a decision to develop a strategy regarding the further public debt regulation. Thus, till the 2007 year an appropriate policy has been in action. Its implementation allowed to reduce the pace of Ukrainian public debt accumulation and keep it on the same level, that can be seen on the Figure 2.3. This, at the same time, helped to sufficiently reduce the value of debt to GDP ratio – from 59% in 1999 year to 12,3% in 2007 year.

The financial crisis in 2008 reflected on the Ukrainian public debt and provoked its increase both in absolute and relative to the GDP values. Because of hryvnia devaluation the debt security of the country has deteriorated significantly. The public debt started to rise sharply because of the large amount of financial resources that have been attracted via debt instruments like government bonds and were sold to non-residents in foreign currency. Such policy provoked the reduction of business activity, narrowing the tax basis and, consequently, an increase of state budget deficit that required further attraction of funds even in larger volumes [21]. Because of this financial crisis the public debt increased from 17 573 million USD in 2007 year to 55 256 million USD in 2010 year, while debt to GDP ratio raised from 12,3% in 2007 year to 40,6% in 2010 year.

In 2011-2014 years Ukraine has made an attempt to pay attention again on the effectiveness of the public debt regulation in the country. Thus, new policy was focused on the public debt volume reduction, its structure change and an internal financial market development [21]. As it can be seen on the Figure 2.3, despite that the debt has been rising in absolute values during these years, the debt to GDP ratio stopped to grow and have been remaining almost on the same level.

In 2014 year one more crisis caused the sharp increase of Ukrainian public debt. The debt to GDP ratio increased from 40,1% in 2013 year to 81,0% in 2016 year. Such values of debt to GDP ratio exceeded its higher boundaries set both by Ukrainian government and international financial institutions. Thus, according to the Ukrainian law, the public debt should not exceed 60% of GDP [56], while in fact its value in Ukraine was higher starting from 2014 year and became lower just in 2019 (50,3%) and 2021 (48,9%) years, that indicated about the absence of effective control over the public debt.

In 2021 year, in the context of key indicators of public debt, Ukraine had quite satisfactory results. In the Table 3.1 there are shown the key indicators of public debt for Ukraine and, as Ukraine is oriented on the European countries, the values of the same indicators for countries which are the members of European Union (27 countries).

Debt to GDP ratio and debt per capita indicator make it possible to compare the public debt burden that is caused on the economies of these countries. In comparison with EU-countries Ukraine in 2021 year had quite low public debt burden. Firstly, the debt to GDP ratio in Ukraine was equal to 54,4%, while the average value among EU-countries was 76,2%. In Ukraine this ratio was lower than in most EU-countries and lower than the higher boundary set by Ukrainian government (60%), that ensures for Ukraine 19th place out of 28 countries listed and indicates that the public debt does not cause too big burden on the economy.

The debt per capita indicator is usually used to evaluate the default risk of government and to obtain an understanding of overall economic health of the country. It may help to evaluate the country's ability to pay its public debt service costs in the nearest future [16]. As it can be seen in the Table 3.1, Ukraine has the lowest debt per capita indicator among all EU-countries. Thus, debt per capita in Ukraine equals to 2 345 USD, while among the EU-countries this indicator in average is equal to 26 517 USD. Nevertheless, despite such difference between Ukrainian indicator and other countries indicators, the burden, caused on the majority of other countries' economies, is less tangible. The reason of this lies in economic stability and development of European countries – the more stable it is, the higher debt burden the economy can withstand without suffering from significant negative consequences.

Table 3.1 The key indicators of public debt as of 2021: Ukraine and EU countries

№	Country	Debt to GDP ratio	№	Country	Debt per capita
1.	Greece	206,7 %	1.	Belgium	\$ 56 163
2.	Italy	154,8 %	2.	Ireland	\$ 55 718
3.	Portugal	130,8 %	3.	Italy	\$ 53 467
4.	Spain	120,2 %	4.	France	\$ 48 738
5.	France	115,8 %	5.	Austria	\$ 44 233
6.	Belgium	113,4 %	6.	Greece	\$ 40 310
7.	Cyprus	111,0 %	7.	Germany	\$ 35 678
8.	Croatia	87,0 %	8.	Spain	\$ 35 667
9.	Austria	84,2 %	9.	Finland	\$ 35 566
10.	Slovenia	77,2 %	10.	Luxembourg	\$ 33 271
11.	Hungary	76,6 %	11.	Cyprus	\$ 32 037
12.	Germany	72,5 %	12.	Portugal	\$ 30 968
13.	Finland	72,2 %	13.	Netherlands	\$ 30 327
14.	Malta	63,0 %	14.	Denmark	\$ 24 980
15.	Slovakia	61,4 %	15.	Sweden	\$ 21 943
16.	Netherlands	58,1 %	16.	Slovenia	\$ 21 807
17.	Ireland	57,4 %	17.	Malta	\$ 18 985
18.	Poland	55,5 %	18.	Hungary	\$ 13 963
19.	Ukraine	54,4 %	19.	Croatia	\$ 13 396
20.	Romania	51,1 %	20.	Slovakia	\$ 13 270
21.	Latvia	47,6 %	21.	Czechia	\$ 11 411
22.	Lithuania	47,4 %	22.	Lithuania	\$ 10 380
23.	Czechia	45,0 %	23.	Poland	\$ 9 590
24.	Sweden	39,6 %	24.	Latvia	\$ 9 208
25.	Denmark	38,7 %	25.	Romania	\$ 7 183
26.	Luxembourg	26,3 %	26.	Estonia	\$ 4 925
27.	Bulgaria	25,0 %	27.	Bulgaria	\$ 2 768
28.	Estonia	20,0 %	28.	Ukraine	\$ 2 345

Source: created based on the World Bank data [10],[34]

Despite that in 2021 year Ukrainian indicators were showing positive tendency, it cannot be said that in nearest future years an overall country's economy health, as well as the public debt issue, will keep the same positive tendency because of the war started in February of 2022 year. As for all other countries, which have national currency

different from dollar and euro, one of the largest weaknesses that Ukraine has related to the public debt is linked with the currency exchange rates fluctuations.

Thus, the first negative factor that has significant impact on the today's public debt of Ukraine is the devaluation of Ukrainian hryvnia that has been caused by war. During 2,5 months, starting from the 21st of February, the Ukrainian hryvnia has devaluated on 6,5% that will influence on that part of public debt, which has been taken in foreign currency, different from hryvnia. It will increase not only the public debt as it is, but also debt servicing costs and burden of debt on Ukrainian economy.

The second factor that will influence on the Ukrainian public debt in 2022 year is the high need in funds that will occur in order to resuscitate the economy, support it and renew all destroyed buildings and infrastructure in affected cities (in case if the war ends in 2022 year). As a lot of manufacturing capacities have been damaged, in further few years business activity will be lower than it was and, consequently, Ukraine will not be able to keep the same level of GDP. Moreover, the tax basis will also be lower, that, most likely, will lead to the increase of external public debt.

The third factor is related to the long-term prospective. As it was already said, Ukraine will produce lower GDP and the tax basis will decrease. The process of economic recovery is not fast and takes at least few years. Together with a decrease in government revenues there will be an increase in budget expenditures, that during a few years will negatively influence on the state budget deficit, that, in turn, will cause an increase in funds attraction necessity and, consequently, public debt volume.

As the effectiveness of public debt regulation policy directly influences on the debt security and stability of the economy, it is quite important to develop a competent strategy regarding future Ukrainian loans regulation. This strategy should take into account all possible ways of risk minimization. Firstly, the share of internal public debt should be increased as much as it is possible. This will allow to reduce the share of debt in foreign currency and, consequently, minimize the risk linked with the exchange rates fluctuations in the future, increase the debt security of Ukraine and reduce its dependency from other countries who lent money to Ukraine.

Secondly, the public debt strategy should be also focused on the ensuring an even repayment schedule. It means that while taking every new loan those charged ones must consider the repayment schedule of those loans which the country already has. Such well-balanced policy will allow to smooth peaks of debt servicing payments and avoid big spikes of debt servicing payments which would have a big burden of the economy.

The long-term strategy should also include the internal security market development and rising the trust to authorities. These two aspects in combination may have very positive effect in terms of funds attraction via internal market and reducing the cost of debt that will have positive impact on the country's economy stability. Moreover, the more stable the economy is, the lower are interest rates on loans for both private sector and country, thus, if Ukraine manages to reach the stability in the nearest years after the war ends, then the burden of existed debt will become lower, and the further loans will become cheaper.

In general, the public debt management system can be represented in the following way (Figure 3.5):

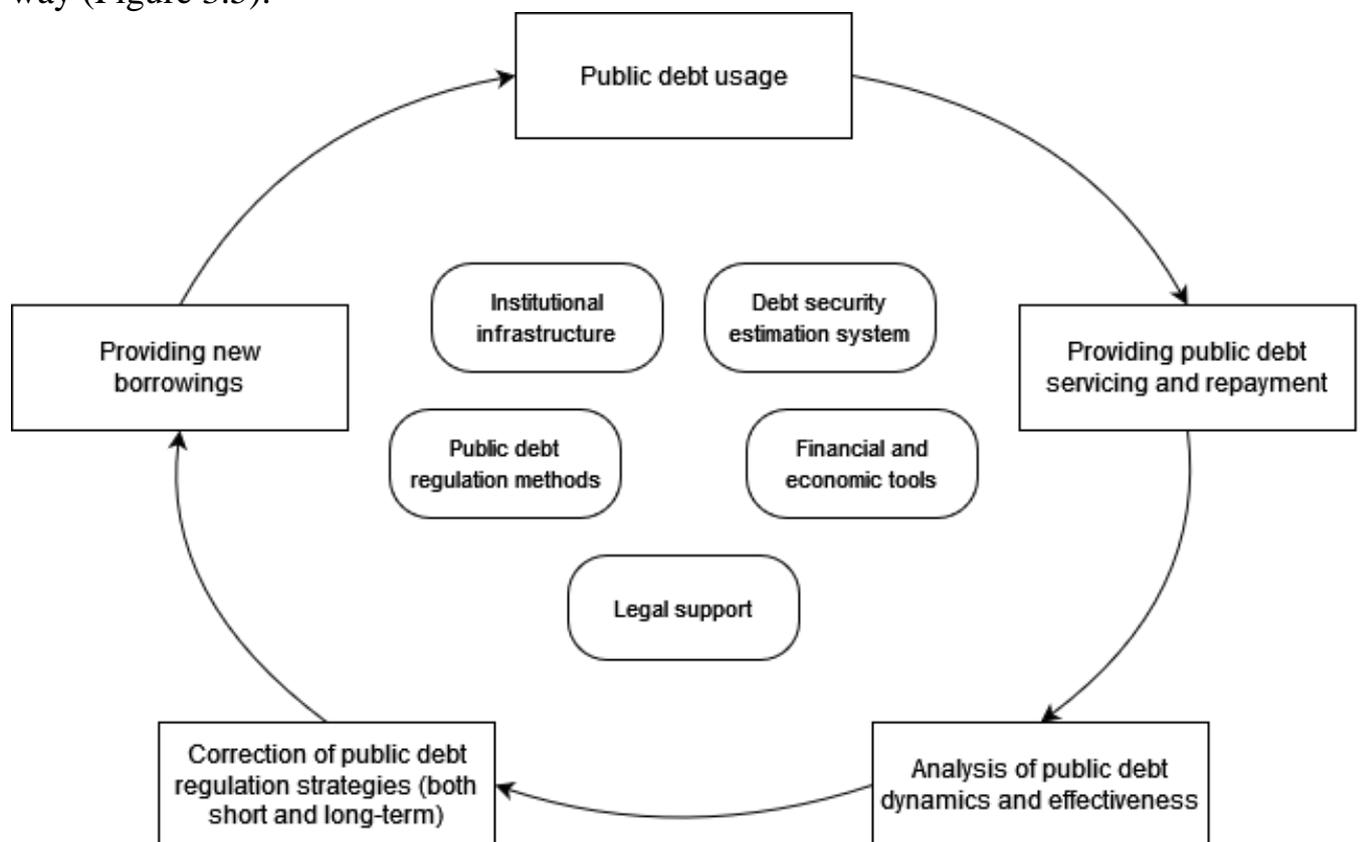


Figure 3.5 – The scheme of public debt management system

Source: created based on the [61]

The primary element in the system is analysis of public debt dynamics and effectiveness. This process aims to reveal problematic areas and define the core tasks which future strategy should be based on.

Next element – correction of public debt regulation strategies (or their creation if such do not exist yet). This stage implies making corrective amendment in the country's strategy regarding public debt. Of course, these changes should be based on the results and conclusions of analysis, made on the previous stage. A key goal for the strategy should be ensuring the full repayment of debt and its interest in time. Designing and correcting the public debt strategies is one of the most important elements in the system, because exactly its correctness determines the effectiveness on public debt regulation and, consequently, influences on the whole country's development.

While describing this stage it is also worth to mention fiscal consolidation. Under this notion it is implied a row of targeted measures which the government takes in order to provide a budget deficit and public debt optimization. The core aims of this consolidation are to reach a balance in the system of public finance, ensure a macroeconomic stability and maximize the public welfare by using budget resources, budget expenditures, budget deficit and public debt as instruments of fiscal consolidation. Thus, by operating the public debt regulation strategy and by analyzing the core fiscal parameters, it can be determined the target points of fiscal consolidation, that reveals itself in the medium-term plan, approved by legislation [61].

The stage of providing new borrowings should rely on the strategy created. The government should stick to the characteristics of new loans, provided by the plan, and find the most beneficial source of funds to borrow. For example, such important characteristics as new loans costs and its term.

The public debt usage also is one of the most important stages. The best option of public debt usage in the context of economic development is its transformation in the source of investment resources. Such investments, provided with the help of borrowed funds, are usually directed to the reformation in the context of quality of the public administration and economic activity spheres and, besides this, on the modernization of manufacturing processes and its expansion. The most effective investments nowadays are

investments in innovations. They allow to transform the funds borrowed in the investments in the human capital and in the development of innovations in the business activity, that is a driver of scientific progress and economic development. Thus, the key idea of this stage is to avoid an ineffective debt usage.

Providing public debt servicing and repayment stage is fully determined by the previous stages. However, the correctness of its planning, provided in the preliminary stages, has a significant impact on the economy of the country. The main task of this element of the system is to ensure a uniform distribution of debt servicing and repayment payments over time, in other words – to smooth possible spikes of payments, that helps to reduce a burden, caused on the economy in a given period of time.

In the center of a scheme there are shown several elements which represent different tools and parts, needed to provide the stages highlighted. The institutional infrastructure includes a row of management and control bodies in the public debt sphere, which main task is to provide a control over the correspondence between the public debt regulation results and a strategy, designed earlier. In accordance with Ukrainian legislation, this institutional infrastructure includes Verkhovna Rada of Ukraine, Ministry of Finance of Ukraine, State Treasury Service of Ukraine, National Bank of Ukraine, State Audit Service of Ukraine and the Accounting Chamber of Ukraine [61].

The main task of debt security estimation system is to evaluate the debt burden that the debt causes on the county's economy. By calculating and analyzing the level of public debt, its cost and different ratios, this system gives an opportunity for those charged ones to reveal possible threats, for example – early stage of debt crisis, that reveals in exceeding safe levels of debt indicators and in problems with providing debt servicing and repayment payments. Thus, by making an estimation needed and by taking appropriate measures, the government can avoid disbalances in the system of public finance and ensure stable economic development of the country.

Public debt regulation methods are mostly related to cases, when the public debt causes too high burden on the economy and, consequently, there is a need in its restructuring. To the row of such methods can be included conversion, refinancing, consolidation, unification and the loan postponing or annulment.

Financial and economic tools are used by the government to regulate financial processes in the country. The most important ones in the aspect of public debt are interest rates for loans and exchange rate regulation.

A legal support is formed by such documents as public debt management programs which are designed each year for the next year. These programs include the information about a new loans volume that will be taken, debt instruments which will be used and a row of main characteristics of public debt for the coming year.

So, by using system dynamics method the system of interconnections has been modeled, that gave an opportunity to obtain full understanding of how this system works and what causes the public debt to raise or decrease. To the model given has been included a row of the most significant drivers of the system, which, in general, have successfully reproduced the historical Ukrainian public debt's dynamics. The model confirmed that the most significant force, that moves the system, is a reinforcing loop that in reality is called a debt spiral and connects the state budget deficit with public debt.

Two scenarios, which have been studied (the baseline and lower shadow economy scenario), showed the following results: according to the model, the non-guaranteed public debt in 2025 year will be equal to 2 210 000 million UAH due to baseline scenario and would be equal to 1 220 000 million UAH in case of lower shadow economy scenario; the non-guaranteed debt to GDP ratio in 2025 year will be equal to 42% due to baseline scenario and would be equal to 21% in case of lower shadow economy scenario. As the modeling for future years has been provided under conditions of the most possible scenario after war (reducing of GDP and government revenues in 2022 year), the system predicts an increase of Ukrainian public debt in the following years.

Overall, the Ukrainian public debt dynamics in the last years demonstrates a positive trend, that is reflected on the public debt indicators' dynamics. The debt to GDP ratio has decreased from 81% in 2016 year to 48,9% in 2021. The internal debt share also has raised – from 34,6% in 2016 year to 39,7% in 2021. The strategy designed shows good results which helps to make the economy of Ukraine less sensitive to the exchange rates fluctuations and reduce the funds outflow from country.

However, the war, started in February 2022, is about to change this tendency in the opposite way. There is a row of negative factors which indicate about a future public debt increase in Ukraine. Firstly, the GDP and government revenues are expected to decrease sufficiently in the following year. Secondly, there will be a very high need in financial resources to renew the country's infrastructure and manufacturing capacities. As the result – the state budget deficit will raise, that will increase the need in new loans. Thus, Ukraine and Ukrainian public debt dynamics will depend on the decisions of western partners, their readiness and ability to provide further financial assistance on a free basis.

CONCLUSIONS

Under modern conditions it is unreal to fully meet all needs of the country without other entities assistance, that is why public debt became an integral part of every economy. The need in taking debts by government mostly is caused by the state budget deficit or, to a lesser extent, by a willing to finance certain investment projects and programs. The role of creditors can be played by different supranational unions, international financial institutions, other governments, banks, native and foreign companies and citizens.

The public debt, as a source of investment resources, aims to boost the economy and support it, but it also has a row of possible negative threats. The most dangerous one is a debt spiral, that occurs in result of covering a chronic budget deficit by taking new loans and low effectiveness of debt usage, that can jeopardize the country's stability and solvency. Despite it, one more significant factor for Ukraine is a currency exchange rate, because its fluctuations have a direct impact on the external debt volume. The high debt burden negatively influences on the population's wellbeing and economic development. All of these allow to obtain an understanding of how important the debt regulation is.

Generally, the debt regulation strategy should be designed in a such way, that will allow to provide debt repayment and interest payments, reduce the risks and costs, ensure the structure optimality and further development of the country. As of 2021 year, the public debt of Ukraine is 2 671 827,6 million UAH, that equals to 48,9% of GDP (debt to GDP ratio). It is lower than higher boundary (60%) and is on 11,9% lower than in 2020 year. Overall, the Ukrainian public debt's structure as of 2021 year is the following:

- 49% – external public debt;
- 40% – internal public debt;
- 10% – guaranteed external public debt;
- 2% – guaranteed internal public debt.

Due to a high share of external debt there is a funds outflow from Ukrainian economy in the form of interest rate payments. Also, 63,22% of total public debt is on the foreign currency, while the higher burden is considered to be equal to 60%, that makes

the Ukrainian economy very sensitive to the exchange rate fluctuations and implies high risk. However, starting from 2011 year, the funds, attracted via internal government bonds have raised from 33,5% to 39,7% of total public debt, that indicates that internal security market is developing and internal debt share becomes higher.

An internal debt is less harmful because, firstly, the funds outflow from country is absent and, secondly, it is mostly in national currency, thus, the currency risk is also not applicable. Moreover, an internal debt has lower cost – average yield of internal government bonds issued in US dollar and Euro was 3,75% and 2,45% respectively, while on external market Ukraine issues Eurobonds with the interest rate of 8-12%.

One of the most common indicators of debt security is debt to GDP ratio. As of 2021 year in Ukraine it equals to 48,9% – the lowest value for the last 7 years, however, it still corresponds to the dangerous zone. In order to make the debt security higher, the debt strategy of Ukraine should focus on such aspects:

- risk reduction (currency risk, insolvency risk);
- increasing an internal debt share (allows to reduce the debts cost, avoid a funds outflow from the country and ensures a financial security preservation);
- ensuring an even repayment schedule (taking into account the debt, that the government already has, and the schedule of its repayment allows to smooth the spikes of future payments and decrease the debt burden);
- internal market development (allows to attract more funds on the internal market and, consequently, to reduce risks and make the loans more beneficial for government);
- ensuring an effective debt usage (an appropriate investments can positively influence on the country's revenues, that will allow to generate a sufficient amount of money for debt repayment and providing further investments).

To design an effective debt regulation strategy it is also important to study the dynamics of country's public debt and its dependency from different factors. According to the econometrics model built, if the state budget deficit rises on 1 percentage point, then the public debt rises on 10 billion \$; if the excess of export over import rises on 1% then the public debt rises on 13,72 billion \$; if the corruption level rises on 1 position,

then the public debt rises on 4,63 billion \$. An understanding of factors weight and significance can help to determine core points of the strategy and increase its efficiency.

The system dynamics model allows to obtain an understanding of the whole system and all interconnections between the system's parts. The model reproduces the historical trend of Ukrainian public debt and other indicators, thus, it can be said that the most important and significant factors were included in the system. The model confirmed that the main force, that dominates in the system, is a reinforcing loop between the public debt volume and budget deficit. The simulation has been made within two scenarios: the baseline and lower shadow economy. So, according to the model, the non-guaranteed public debt in 2025 year will be equal to 2 210 000 million UAH due to baseline scenario and would be equal to 1 220 000 million UAH in case of lower shadow economy scenario. The non-guaranteed debt to GDP ratio in 2025 year will be equal to 42% due to baseline scenario and would be equal to 21% in case of lower shadow economy scenario.

To sum up, in the last years the Ukrainian government started to provide a strategy, that positively reflects on the public debt indicators' dynamics. The debt to GDP ratio decreases over time – from 81% in 2016 year to 48,9% in 2021. The internal debt share also rises – from 34,6% in 2016 year to 39,7% in 2021, that makes the economy of Ukraine less sensitive to the exchange rates fluctuations and eliminates the funds outflow. Also, international reserves to external debt ratio remains on its optimal level (54%).

However, in connection with war, that started in Ukraine in February 2022, this positive trend is unlikely to be saved in the future few years. The issue of Ukrainian public debt now is in the state of uncertainty, because it is hard to predict how long this war will continue, how long the European and other countries will be able to provide a financial support for Ukraine on a free basis and, that is not less important, how big will be a Ukrainian GDP loss in further years. But, it can be said with a high confidence, that the Ukrainian budget deficit will raise in nearest future with a great pace, that will generate the larger and larger need in additional financial support and, thus, other countries assistance. The most likely scenario, anyway, implies an increase of Ukrainian public debt and a decrease of GDP with its further gradual recovery, thus, the debt burden is likely to become higher in coming years and break the upper bound of 60%.

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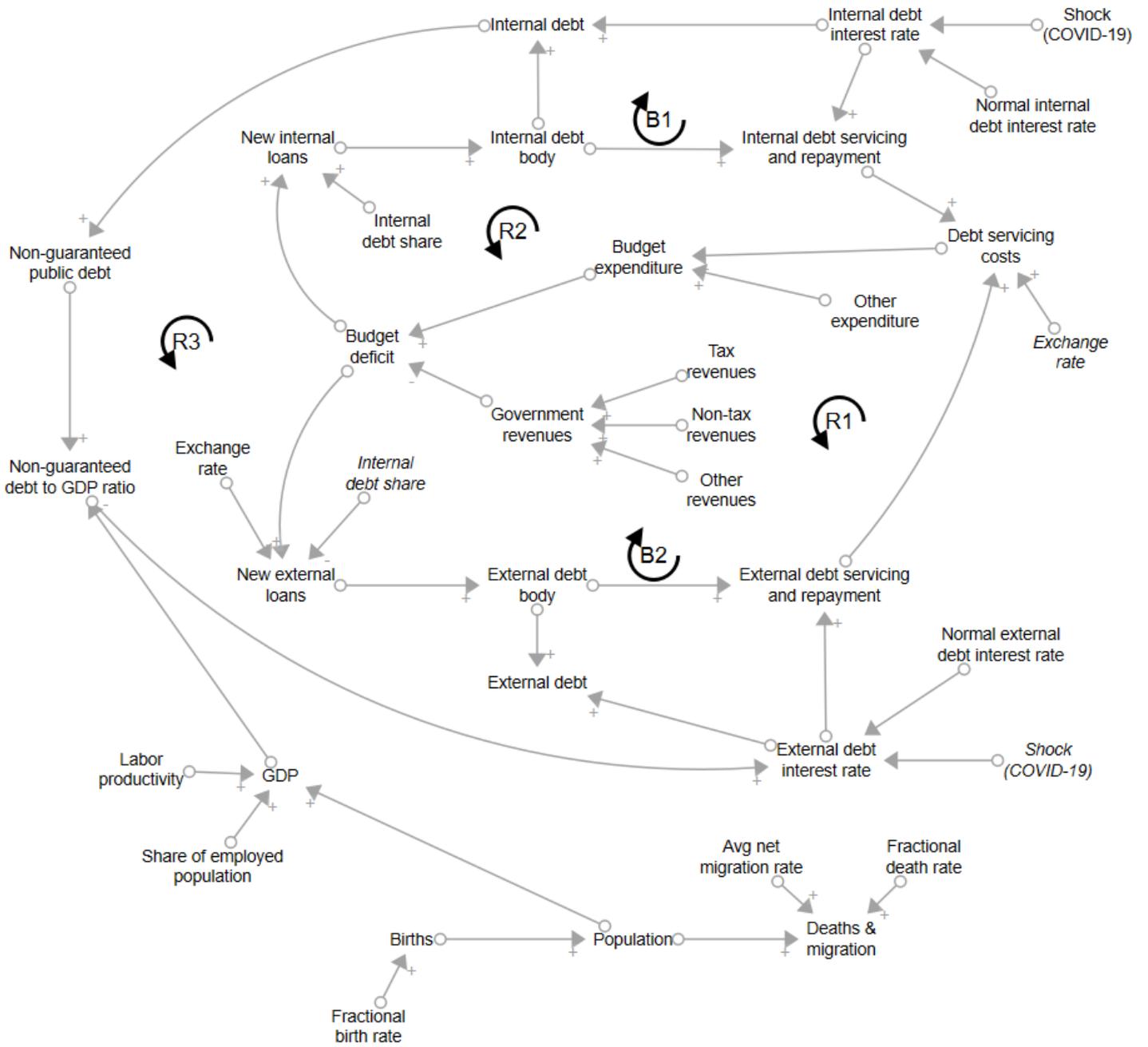
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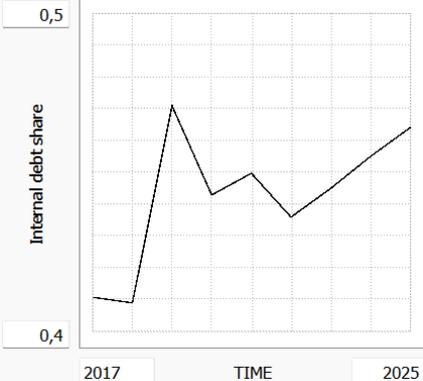
APPENDIX A

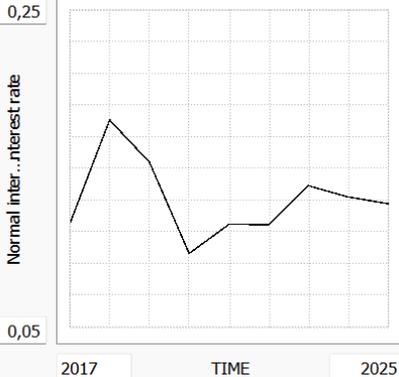
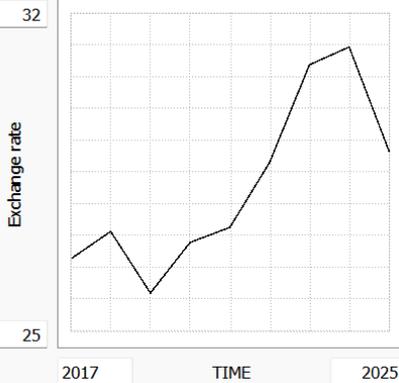
Casual loop diagram (CLD)



Source: made by author in the Stella Architect software

APPENDIX B

Description of variables	
Internal debt body (initial stock value) = 766678,9	
Description: represents the value of internal debt body over time. <i>Source: based on data [20],[45]</i>	Units: million UAH
New internal loans (inflow to the Internal debt body) = IF Budget_deficit > 0 THEN Budget_deficit*Internal_debt_share ELSE 0	
Description: represents an amount of new internal loans which have been taken by the government in a certain year.	Units: million UAH/Year
Internal debt servicing and repayment (outflow from the Internal debt body) = Internal_debt_body/21,87761075 + Internal_debt_body*Internal_debt_interest_rate	
Description: represents an amount of funds that the government should spend for providing yearly debt servicing and repayment (body of debt divided on average debt term + yearly interest rate). <i>Source: based on data [20],[22]</i>	Units: million UAH/Year
External debt body (initial stock value) = 48989,4	
Description: represents the value of external debt body over time. <i>Source: based on data [22],[45]</i>	Units: million USD
New external loans (inflow to the External debt body) = IF Budget_deficit > 0 THEN (Budget_deficit*(1 - Internal_debt_share)) / Exchange_rate ELSE 0	
Description: represents an amount of new external loans which have been taken by the government in a certain year. As the amount of debt needed is determined by the budget deficit, that is in the million UAH, and the external debt is in million USD, the value in million UAH has been divided on the exchange rate. <i>Source: based on data [4]</i>	Units: million USD/Year
External debt servicing and repayment (outflow from the External debt body) = External_debt_body/11 + External_debt_body*External_debt_interest_rate	
Description: represents an amount of funds that the government should spend for providing yearly debt servicing and repayment (body of debt divided on average debt term + yearly interest rate). <i>Source: based on data [22]</i>	Units: million USD/Year
Internal debt share = GRAPH (TIME)	
Description: represents the share of internal debt in total debt over time. <i>Source: based on data [45]</i>	Units: dmnl
Shock (COVID-19) = 1	
Description: the value of 1 activates the presence of COVID-19.	Units: dmnl

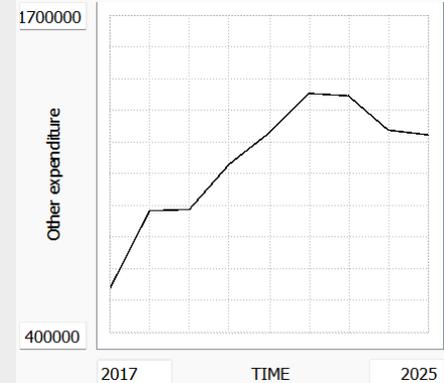
<p>Normal internal debt interest rate = GRAPH (TIME)</p>	
<p>Description: represents an average interest rate of internal debt withing every period (year). <i>Source: based on data [20]</i></p>	<p>Units: dmnl</p>
<p>Internal debt interest rate = IF "Shock_(COVID-19)" = 1 THEN Normal_internal_debt_interest_rate*(1 + RAMP(0,75; 2019; 2021) – RAMP(0,6; 2021; 2022)) ELSE Normal_internal_debt_interest_rate</p>	
<p>Description: represents an interest rate of internal debt withing every period (year), adjusted for a Shock (COVID-19). If the Shock (COVID-19) is absent, the variable given equals to Normal internal debt interest rate, if the shock is ON, the interest rate adjusts.</p>	<p>Units: dmnl</p>
<p>Internal debt = Internal_debt_body + Internal_debt_body*Internal_debt_interest_rate</p>	
<p>Description: represents the total value of non-guaranteed internal public debt, including interest.</p>	<p>Units: million UAH</p>
<p>Average external debt interest rate = 0,0733832111373849</p>	
<p>Description: represents an average interest rate of external loans. <i>Source: based on data [22]</i></p>	<p>Units: dmnl</p>
<p>External debt = External_debt_body + External_debt_body*External_debt_interest_rate</p>	
<p>Description: represents the total value of non-guaranteed external public debt, including interest.</p>	<p>Units: million USD</p>
<p>Non-guaranteed public debt = Internal_debt + Internal_debt*1,296577238</p>	
<p>Description: represents the total value of non-guaranteed public debt, including interest. Calculated as the sum of internal rate and internal debt multiplied on a coefficient, which represents how many times an external debt exceeds an internal one.</p>	<p>Units: million UAH</p>
<p>Non-guaranteed public debt to GDP ratio = "Non-guaranteed_public_debt" / GDP</p>	
<p>Description: the ratio between the non-guaranteed public debt and GDP.</p>	<p>Units: dmnl</p>
<p>Exchange rate = GRAPH (TIME)</p>	
<p>Description: represents UAH/USD exchange rate. <i>Source: based on data [4]</i></p>	<p>Units: million (UAH/USD)</p>

Debt servicing costs = Internal_debt_servicing_and_repayment + External_debt_servicing_and_repayment*Exchange_rate

Description: represents the yearly total amount of funds that the government should spend for providing debt servicing and repayment. The value of external debt servicing costs in USD are transferred in UAH by multiplting on the exchange rate.

Units: million UAH/year

Other expenditure = GRAPH (TIME)



Description: represents all expenditures from the budget except debt servicing and repayment costs.

Source: based on data [11]

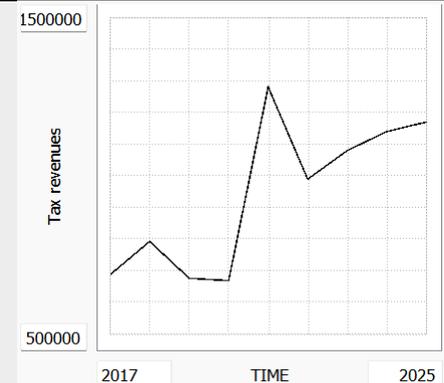
Units: million UAH/year

Budget expenditure = Debt_servicing_costs + Other_expenditure

Description: represents the total amount of budget expenditure in a certain perion (year).

Units: million UAH/year

Tax revenues = GRAPH (TIME)

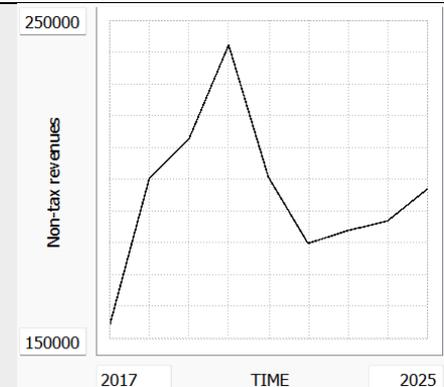


Description: represents funds that the government received from taxes.

Source: based on data [11]

Units: million UAH/year

Non-tax revenues = GRAPH (TIME)



Description: represents funds that the government received in other way than taxes.

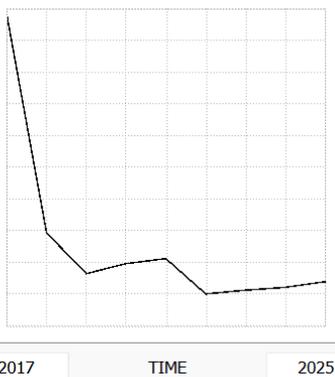
Source: based on data [11]

Units: million UAH/year

Government revenues = Tax_revenues + "Non-tax_revenues" + Other_revenues

Description: represents the total amount of budget revenues in a certain perion (year).

Units: million UAH/year

<p>Other revenues = GRAPH (TIME)</p>	
<p>Description: represents all other government's revenues. Source: based on data [11]</p>	<p>Units: million UAH/year</p>
<p>Budget deficit = -1*(Government_revenues – Budget_expenditure)</p>	
<p>Description: represents the amount of money, on which budget expenditure exceeds budget revenues.</p>	<p>Units: million UAH/year</p>
<p>External debt interest rate = IF "Shock_(COVID-19)" = 1 THEN Avg_external_debt_interest_rate*(1 + "Non-guaranteed_debt_to_GDP_ratio")*(1 + RAMP(0,3; 2019; 2021) – RAMP(0,2; 2021; 2022)) ELSE Avg_external_debt_interest_rate*(1 + "Non-guaranteed_debt_to_GDP_ratio")</p>	
<p>Description: represents an interest rate of external debt withing every period (year), adjusted for a Shock (COVID-19) and economic stability. If the Shock (COVID-19) is absent, the variable given equals to Average external debt interest rate adjusted for economic stability, if the shock is ON, the interest rate adjusts not only on economic stability, but also on this shock.</p>	<p>Units: dmnl</p>
<p>Population (initial stock value) = 42584,5</p>	
<p>Description: represents the population of Ukraine over time. Source: based on data [43]</p>	<p>Units: thousand people</p>
<p>Births (inflow to the Population) = Population*Fractional_birth_rate</p>	
<p>Description: represents a yearly amount of new-born people.</p>	<p>Units: thousand people/Year</p>
<p>Deaths and migration (outflow from the Population) = Population*(Fractional_death_rate + Avg_net_migration_rate)</p>	
<p>Description: represents an amount of people who are no more included in the population of the country.</p>	<p>Units: thousand people/Year</p>
<p>Fractional birth rate = 0,007476761</p>	
<p>Description: represents the pace with which the new-born people appear (as a percentage of country's population). Source: based on data [2],[43]</p>	<p>Units: dmnl/Year</p>
<p>Fractional death rate = 0,014605507</p>	
<p>Description: represents the pace with which people die (as a percentage of country's population). Source: based on data [2],[43]</p>	<p>Units: dmnl/Year</p>
<p>Avg net migration rate = 0,0002082</p>	
<p>Description: represents the pace with which people leave the country as immirgants (as a percentage of country's population). Source: based on data [36],[43]</p>	<p>Units: dmnl/Year</p>

<p>Share of employed population = 0,3671</p> <p>Description: represents the ratio between employed population and total population.</p> <p><i>Source: based on data [43],[53]</i></p> <p style="text-align: right;">Units: dmn1</p>																					
<p>Labor productivity = GRAPH (TIME)</p>	<table border="1"> <caption>Estimated Labor Productivity Data</caption> <thead> <tr> <th>Year</th> <th>Labor Productivity</th> </tr> </thead> <tbody> <tr> <td>2017</td> <td>180</td> </tr> <tr> <td>2018</td> <td>200</td> </tr> <tr> <td>2019</td> <td>220</td> </tr> <tr> <td>2020</td> <td>240</td> </tr> <tr> <td>2021</td> <td>260</td> </tr> <tr> <td>2022</td> <td>380</td> </tr> <tr> <td>2023</td> <td>350</td> </tr> <tr> <td>2024</td> <td>340</td> </tr> <tr> <td>2025</td> <td>360</td> </tr> </tbody> </table> <p style="text-align: right;">Units: million UAH/thousand people</p>	Year	Labor Productivity	2017	180	2018	200	2019	220	2020	240	2021	260	2022	380	2023	350	2024	340	2025	360
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<p>Description: represents an average amount of GDP that is generated by 1 employed human in 1 year.</p> <p><i>Source: based on data [55]</i></p>																					
<p>GDP = Population*Share_of_employed_population*Labor_productivity</p> <p>Description: represents an amount of funds, generated by whole employed population in 1 year.</p> <p style="text-align: right;">Units: million UAH</p>																					