https://doi.org/10.15407/econforecast2019.04.022
JEL: E 62, H 68

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PECULIARITIES OF BUILDING BUDGETARY SUSTAINABILITY INDICATORS IN UKRAINE

To assess fiscal sustainability, the European Commission uses the medium-term and long-term fiscal sustainability indicators $S1$ and $S2$. Variables in the formulas of these indicators are compiled according to the methodology of the European System of National and Regional Accounts 2010 in accordance with the Eurostat's Manual on Government Deficit and Debt. Ukraine compiles the government finance statistics in accordance with the 1986 IMF's Government Finance Statistics Manual.

The same variables of the government finance statistics, compiled according to different methodologies, have different data coverage. Therefore, in Ukraine it is impossible to unconditionally use the formulas of the fiscal sustainability indicators $S1$ and $S2$, whose variables are compiled according to the European methodology. The author adapts the fiscal sustainability indicators $S1$ and $S2$ to the government finance statistics compiled according to the Ukrainian methodology.

The adapted medium-term and long-term fiscal sustainability indicators $S1^{a}$ and $S2^{a}$ differ from their European analogues in that they use the variable of adjusted primary balance instead of the variable of primary balance. The author builds the adapted medium-term and long-term fiscal sustainability indicators $S1^{aв}$ and $S2^{aв}$ taking into account the currency structure of government debt. They differ from the adapted fiscal sustainability indicators $S1^{a}$ and $S2^{a}$, which do not take into account the currency structure of government debt, in that they use the adjusted effective nominal interest rate on the government debt instead of the effective nominal interest rate on the government debt.

The difference between the adapted medium-term fiscal sustainability indicators that take into account and do not take into account the currency structure of government debt ($S1^{aв}-S1^{a}$), as well as the difference between the adapted long-term fiscal sustainability indicators that take into account and do not take into account the currency structure of government debt ($S2^{aв}-S2^{a}$), show the values by which the budget expenditures on the government debt servicing should be additionally adjusted so that such expenditures correspond to the target currency structure of government debt in the medium and long term, respectively.

The retrospective data of Ukraine's government finance statistics (2005-2018), compiled in accordance with the Ukrainian methodology, show how wrong are the estimates of medium-term fiscal sustainability obtained with the use of the European formula of the medium-term fiscal sustainability indicator $S1$, as well as calculate the estimates of additional adjustments to the Ukraine's State Budget expenditures

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on the Ukrainian government debt servicing for different scenarios of the formation of the currency structure of Ukrainian government debt in 2006-2018.

The publication was prepared for the implementation of the R&D "Sustainability of the Public Finances of Ukraine in the Long Term" (State Registration No. 0116U008262).

Keywords: *fiscal gap, fiscal sustainability, fiscal sustainability indicators, adapted fiscal sustainability indicators, currency structure of government debt*

To assess fiscal sustainability, indicators of the *fiscal gap* are used in world practice, which are also called *indicators of fiscal sustainability*.

Fiscal *sustainability* is understood as ‘solvency' of the state, i.e. its ability to service its debt at any point in time [1, c. 32].

The European Commission assesses fiscal sustainability in the medium-term period using the *medium-term fiscal sustainability indicator* $S1$, and in the long-term period – using the *long-term fiscal sustainability indicator* $S2$ [1–2].

However, in Ukraine it is impossible to unconditionally use the formulas of the fiscal sustainability indicators $S1$ and $S2$, which used by the European Commission. The reason is that in Ukraine the methodology for compiling variables of government finance statistics, on the basis of which fiscal sustainability indicators are calculated, differs from that used in the European Union.

The same variables, compiled according to different methodologies, have different data coverage. Therefore, if we use European formulas of fiscal sustainability indicators $S1$ and $S2$, it is necessary to compile Ukrainian variables of government finance statistics (balance of budget, state debt) according to the methodology of the European Union. If we use variables of government finance statistics compiled according to the Ukrainian methodology, it is necessary to adapt European formulas of fiscal sustainability indicators $S1$ and $S2$ to variables compiled according to the Ukrainian methodology.

In assessing fiscal sustainability, it is also necessary to take into account the currency structure of state debt, because the solvency of the state generally depends on its solvency in individual currencies.

The **purpose** of this article is to adapt European formulas of fiscal sustainability indicators $S1$ and $S2$ to variables of Ukrainian government finance statistics and to take into account the currency structure of state debt in adapted formulas.

Member States of the European Union compile government finance statistics according to the methodology of the *European System of National and Regional Accounts 2010* (ESA 2010)) [3] in accordance with the Eurostat's *Manual on Government Deficit and Debt* [4]. The European System of National and Regional Accounts 2010 is the adaptation of the System of National Accounts 2008 (SNA 2008) [5] to the context of the European Union.

Ukraine compiles the government finance statistics in accordance with the *1986* IMF's *Government Finance Statistics Manual* (GFSM 1986 [6]) [7]. The concepts of debt, deficit/surplus of budget and financing, represented in this Manual, Ukraine had enshrined in its legislative acts, in particular in the Budget Code of Ukraine [8][2].

[2] As for the receipts from the *privatization* of state property, in the Budget Code of Ukraine they are treated as *financing* of the budget [8, para. 51 of Part 1 of Article 2 of Chapter 1 of Section I], while in the 1986 IMF's Government Finance Statistics Manual - as the *lending*

In the *European System of National and Regional Accounts 2010*, data is accounted on an *accrual* basis , i.e. on the basis of accrued amounts, and in the *1986* IMF's *Government Finance Statistics Manual* – on a *cash* basis, i.e. on the basis of actual payments. As a result, the same variables of the government finance statistics, compiled according to these methodologies, are incomparable due to different data coverage.

In the *2001 IMF's Government Finance Statistics Manual* (GFSM 2001) [10], there was a transition from data accounting on a cash basis to data accounting on an accrual basis. Variables of government finance statistics, compiled in accordance with the IMF's GFSM in the 2001 edition, as well as in the next edition in 2014 (GFSM 2014) [11], became comparable with the same variables, compiled in accordance with the *European System of National and Regional Accounts 2010*.

Ukrainian scientists have repeatedly noted the need to transit to new international standards for compiling government finance statistics, in particular, to the *2001 IMF's Government Finance Statistics Manual* [12–14] and to the *2014 IMF's Government Finance Statistics Manual* [15–18].

But until such transition takes place, in assessing fiscal sustainability of Ukraine it is necessary to use formulas of fiscal sustainability indicators $S1$ and $S2$, adapted to the Ukrainian government finance statistics.

As shown in the author's previous article [19], the medium-term fiscal sustainability indicator $S1$ is derived from the *budget constraint for a finite period of time*, and the long-term fiscal sustainability indicator $S2$ – from the *budget constraint for an infinite period of time* (*intertemporal budget constraint*). The intertemporal budget constraint follows from the budget constraint for a finite period of time. The budget constraint for a finite period of time is derived from the *one-period budget constraint in relative variables*, and that – from the *one-period budget constraint in absolute variables*:

$$\begin{array}{cl}
\begin{array}{c} one-period\ budget\ constraint \\ in\ absolute\ variables \end{array} & \\
\Downarrow & \\
\begin{array}{c} one-period\ budget\ constraint \\ in\ relative\ variables \end{array} & \\
\Downarrow & \\
budget\ constraint\ for\ a\ finite\ period\ of\ time & \Rightarrow\ S1\,indicator \\
\Downarrow & \\
intertemporal\ budget\ constraint & \Rightarrow\ S2\,indicator.
\end{array}$$

Adaptation of European formulas of fiscal sustainability indicators $S1$ and $S2$ to the Ukrainian government finance statistics begins with adaptation of the *one-period budget constraint in absolute variables*.

The *one-period budget constraint in absolute variables*, written in variables of

minus repayments. Later the IMF revised its recommendations on receipts from the privatization of state property and proposed to consider such receipts as financing. However, no relevant modification was made to the 1986 IMF's Government Finance Statistics Manual. Nevertheless, the new recommendation is applied in practice [9, p. 67]. Ukraine has enshrined the IMF's practical recommendation on receipts from the privatization of state property in its legislation and has been applying it since 2002.

the *European* government finance statistics, is given by formula (1) or, in other variables, formula (2). Formula (1) follows from formula (2):

$$\underbrace{Б_t - Б_{t-1}}_{change\ in\ debt} = \underbrace{r_t \cdot Б_{t-1}}_{\substack{expenditures\ on \\ the\ state\ debt \\ servicing}} - \underbrace{ПС_t}_{\substack{primary\ balance \\ of\ budget}}, \quad (1)$$

$$\underbrace{Б_t - Б_{t-1}}_{change\ in\ debt} = \underbrace{-\underbrace{\left(Д_t - \left(В_t + r_t \cdot Б_{t-1}\right)\right)}_{balance\ of\ budget}}_{financing\ of\ budget}, \quad (2)$$

where $Б_t$, $Б_{t-1}$ – state debt (according to the European methodology) at the end of years t and $(t-1)$, respectively, *units of national currency*; r_t – effective nominal interest rate on the state debt in year t, annual, *coefficient*; $ПС_t$ – primary balance of budget (according to the European methodology) in year t ($ПС_t = Д_t - В_t$); $Д_t$ – revenue of budget (not including revenue from placements of assets) (according to the European methodology) in year t, *units of national currency*; $В_t$ – expenditure of budget (not including expenditures on the state debt servicing) (according to the European methodology) in year t, *units of national currency*.

Formula (2) links the dynamics of state debt to the balance of budget:

$$Change\ in\ debt = \underbrace{-\ Balance\ of\ budget}_{financing\ of\ budget}$$

where the balance of budget, taken with an opposite sign, is equal to the financing of budget:

$$Financing\ of\ budget = -Balance\ of\ budget\,.$$

The mathematical notation of formula (2) is determined by the coverage that variables of balance of budget and state debt have in accordance with the European methodology for compiling variables of government finance statistics.

Since the *balance of budget* according to the European methodology is the variable of *net lending / net borrowing* (*net lending* means a *positive* balance of budget, and *net borrowing* – a *negative* balance of budget), it is linked to debt dynamics by such formula as formula (2).

According to the Ukrainian methodology for compiling government finance statistics, variables of balance of budget, financing of budget and state debt have different coverage than the same variables, compiled according to the European methodology. Therefore, the relationship between the dynamics of state debt and the balance of budget in the variables of the Ukrainian government finance statistics will be expressed by different formula than formula (2).

The *balance of budget*, according to the Ukrainian methodology, is the variable of *surplus/deficit* (*surplus* means a *positive* balance of budget, and *deficit* – a *negative* balance of budget).

The balance of Ukraine's budget is determined taking into account the *balance of lending* of Ukraine's budget [8, para. 21 and para. 44 of Part 1 of Article 2 of Chapter 1 of Section I].

The *balance of lending* of Ukraine's budget is the difference between the funds provided from the budget of Ukraine to the loan and those received by Ukraine's budget to repay loans provided from Ukraine's budget.

The balance of lending of Ukraine's budget is related to the *state-guaranteed debt*.

According to the Ukrainian legislation, the *state-guaranteed debt* consists of debt liabilities of economic entities – residents as direct borrowers, whose fulfillment is secured by state guarantees [8, para. 17 of Part 1 of Article 2 of Chapter 1 of Section I]. It is not a *state* debt, because the *state debt* consists exclusively of the debt liabilities of the state as a direct borrower [8, para. 20 of Part 1 of Article 2 of Chapter 1 of Section I]. But if a guarantee event arises, the state fulfills the debt liabilities of economic entities to creditors. As a result, economic entities become debtors of the state in the amount of debt liabilities repaid by the state instead of them. Payments made by the state to fulfill its guarantee liabilities for such economic entities are recorded as *loans provided from Ukraine's budget* to such economic entities [8, Part 7 of Article 17 of Chapter 3 of Section I].

$$\textit{Balance of Ukraine's budget} = Д_t - (В_t + r_t \cdot Б_{t-1}) - Кр_t, \tag{3}$$

where $Д_t$ – revenue of Ukraine's budget (not including revenue from placements of assets) (according to the Ukrainian methodology) in year t, *units of national currency*; $В_t$ – expenditure of Ukraine's budget (less expenditures on the state debt servicing) (according to the Ukrainian methodology) in year t, *units of national currency*; r_t – effective nominal interest rate on the state debt of Ukraine in year t, annual, *coefficient*; $Б_t$ – state debt of Ukraine (according to the Ukrainian methodology) at the end of year t, *units of national currency*; $Кр_t$ – balance of lending of Ukraine's budget (according to the Ukrainian methodology) in year t, *units of national currency*.

Financing of Ukraine's budget in accordance with Ukrainian legislation consists of financing by debt operations ($БО_t$), financing from state property privatization (relative to the state budget) ($Пр_t$) and financing from active transactions ($АО_t$) [20]:

$$\textit{Financing of Ukraine's budget} = \underbrace{БО_t}_{\substack{\textit{financing}\\ \textit{by debt}\\ \textit{operation}}} + \underbrace{Пр_t}_{\substack{\textit{financing}\\ \textit{from state property}\\ \textit{privatization}}} + \underbrace{АО_t}_{\substack{\textit{financing}\\ \textit{from active}\\ \textit{transactions}}}, \tag{4}$$

where $БО_t$ – amount of financing of Ukraine's budget by debt operation in year t, *units of national currency*; $Пр_t$ – amount of financing of Ukraine's budget from state property privatization in year t, *units of national currency*; $АО_t$ – amount of financing of Ukraine's budget from active transactions in year t, *units of national currency*.

The amount of *financing* of Ukraine 's budget *by debt operations*, or the amount of *debt financing* of Ukraine's budget ($БО_t$) consists of the difference between the amount of funds raised to Ukraine's budget through state *borrowings* and the amount of funds paid from Ukraine's budget to *repay* state debt and the amount of the adjustment.

Theoretically, the amount of *debt financing* of Ukraine's budget ($БО_t$) is equal to the *change in state debt* of Ukraine ($Б_t - Б_{t-1}$). But for different reasons (for example, because of the difference in exchange rates, which affects the change in state debt, or because of the deviation of the issue price of government bonds from their nominal value, which affects the amount of debt financing) [6, p. 196–197] this relationship is not rigid. It is expressed as formula (5):

$$\underbrace{Б_t - Б_{t-1}}_{change\,in\,debt} = \underbrace{БО_t}_{\substack{financing\\ by\,debt\\ operation}} + \Delta_t\,, \tag{5}$$

where $Б_t$, $Б_{t-1}$ – state debt of Ukraine at the end of years t and $(t–1)$, respectively, *units of national currency*; $БО_t$ – amount of debt financing of Ukraine's budget in year t, *units of national currency*; Δ_t – the value, by which change in state debt deviates from the amount of debt financing of Ukraine's budget in year t, *units of national currency*.

From the fact that the financing of Ukraine's budget is equal to the balance of Ukraine's budget, taken with the opposite sign (formula (6)),

$$\underbrace{БО_t + Пр_t + АО_t}_{financing\,of\,budget} = -\underbrace{\left(Д_t - (В_t + r_t \cdot Б_{t-1}) - Кр_t\right)}_{balance\,of\,budget}, \tag{6}$$

we derive the formula for the dependence of debt financing of Ukraine's budget ($БО_t$) on the balance of Ukraine's budget (formula (7)):

$$БО_t = -\underbrace{\left(Д_t - (В_t + r_t \cdot Б_{t-1}) - Кр_t\right)}_{balance\,of\,budget} - Пр_t - АО_t\,. \tag{7}$$

Substituting formula (7) into the formula for the change in Ukraine's state debt (formula (5)), we obtain formula (8), which links the dynamics of Ukraine's state debt with the balance of Ukraine's budget:

$$Б_t - Б_{t-1} = -\underbrace{\left(Д_t - (В_t + r_t \cdot Б_{t-1}) - Кр_t\right)}_{balance\,of\,budget} - Пр_t - АО_t + \Delta_t\,. \tag{8}$$

Formula (8) is the *one-period budget constraint in absolute variables*, *adapted* to Ukrainian government finance statistics.

Formula (8) can be written in another way (formula (9)):

$$Б_t - Б_{t-1} = r_t \cdot Б_{t-1} - \underbrace{\left(ПС_t + Пр_t + АО_t - \Delta_t\right)}_{\substack{adjusted\ primary\\ balance\,of\,budget}}, \tag{9}$$

where $Б_t$, $Б_{t-1}$ – state debt of Ukraine (according to the Ukrainian methodology) at the end of years t and $(t–1)$, respectively, *units of national currency*; r_t – effective nominal interest rate on the state debt of Ukraine in year t, annual, *coefficient*; $ПС_t$ – primary balance of Ukraine's budget (according to the Ukrainian methodology) in year t ($ПС_t = Д_t - В_t - Кр_t$, where $Д_t$ – revenue of Ukraine's budget (not including revenue from placements of assets) (according to the Ukrainian methodology) in year t, *units of national currency*; $В_t$ – expenditure of Ukraine's budget (not including expenditures on the state debt servicing) (according to the Ukrainian methodology) in year t, *units of national currency*; $Кр_t$ – balance of lending of Ukraine's budget (according to the Ukrainian methodology) in year t, *units of national currency*), *units of national currency*; $Пр_t$ – amount of financing of Ukraine's budget from state property privatization in year t, *units of national currency*; AO_t – amount of financing of Ukraine's budget from active transactions in year t, *units of national currency*; Δ_t – the value, by which the change in state debt deviates from the amount of debt financing of Ukraine's budget in year t, *units of national currency*.

The *adapted one-period budget constraint in absolute variables* is an analogue to the *European* one-period budget constraint in absolute variables: the adapted formula (8) is an analogue of the European formula (2), and the adapted formula (9) is an analogue of the European formula (1). Adapted formulas differ from their *European* analogues in that they use the variable of the *adjusted primary balance* of budget in *absolute* value ($ПС_t + Пp_t + AO_t - \Delta_t$) instead of the variable of the *primary balance* of budget in *absolute* value ($ПС_t$).

The chain of algebraic transformations from the *adapted one-period budget constraint in absolute variables* to the *adapted fiscal sustainability indicators* $S1^a$ and $S2^a$ is the same as that of their European analogues [19, p. 36–45].

The *adapted medium-term fiscal sustainability indicator* $S1^a$ is calculated either by formula (10) or by the formula of its decomposition (11):

$$S1^a = c^a \cdot (k_2 - k_1 + 1), \tag{10}$$

$$\begin{aligned} S1^a = & \underbrace{\frac{б_0 \cdot \left(\prod_{t=1}^{T} \frac{1+r_t}{1+\gamma_t} - 1 \right)}{\sum_{i=k_1}^{T} \prod_{t=i+1}^{T} \frac{1+r_t}{1+\gamma_t}} - (nc_0 + np_0 + ao_0 - \delta_0) \cdot \frac{\sum_{i=1}^{T} \prod_{t=i+1}^{T} \frac{1+r_t}{1+\gamma_t}}{\sum_{i=k_1}^{T} \prod_{t=i+1}^{T} \frac{1+r_t}{1+\gamma_t}}}_{Component\,1} + \underbrace{\frac{б_0 - б_T}{\sum_{i=k_1}^{T} \prod_{t=i+1}^{T} \frac{1+r_t}{1+\gamma_t}}}_{Component\,2} + \\ & + \underbrace{\left(- \frac{\sum_{i=1}^{T} \left((\Delta nc_i^* + \Delta np_i^* + \Delta ao_i^* - \Delta\delta_i^*) \cdot \prod_{t=i+1}^{T} \frac{1+r_t}{1+\gamma_t} \right)}{\sum_{i=k_1}^{T} \prod_{t=i+1}^{T} \frac{1+r_t}{1+\gamma_t}} \right)}_{Component\,3} + \underbrace{c^a \cdot \frac{\sum_{i=k_1}^{k_2} \left((k_2 - i) \cdot \prod_{t=i+1}^{T} \frac{1+r_t}{1+\gamma_t} \right)}{\sum_{i=k_1}^{T} \prod_{t=i+1}^{T} \frac{1+r_t}{1+\gamma_t}}}_{Component\,4}, \end{aligned} \tag{11}$$

where $S1^a$ – medium-term fiscal sustainability indicator adapted to the government finance statistics of Ukraine, *% of GDP*; c^a – the value of annual adjustment of *adjusted primary* balance of Ukraine's budget ($nc + np + ao - \delta$) during $[k_1; k_2]$ ($[k_1; k_2] \subset [1; T]$), *% of GDP*; k_1 – first year of the annual adjustments period; k_2 – last year of the annual adjustments period; $б_0$ – state debt of Ukraine at the end of year 0, i.e. at the end of year preceding the first year of the medium-term period, *% of GDP*; $б_T$ – state debt of Ukraine at the end of year T, i.e. at the end of the medium-term period, *% of GDP*; r_t – effective nominal interest rate on the state debt in year t, annual, *coefficient*; γ_t – nominal GDP growth rate in year t, *coefficient*; nc_0 – primary balance of Ukraine's budget in year 0, *% of GDP*; np_0 – amount of financing of Ukraine's budget from state property privatization in year 0, *% of GDP*; ao_0 – amount of financing of Ukraine's budget from active transactions in year 0, *% of GDP*; δ_0 – the value, by which the change in state debt deviates from amount of debt financing of Ukraine's budget in year 0, *% of GDP*; Δnc_i^* – change in the primary balance of Ukraine's budget in year i relative to the year 0 ($\Delta nc_i^* = nc_i - nc_0$), *% of GDP*; Δnp_i^* – change in the amount of financing of Ukraine's budget from state property privatization in year i relative to the year 0 ($\Delta np_i^* = np_i - np_0$), *% of GDP*; Δao_i^* – change in the amount of financing of Ukraine's budget from active transactions in year i relative to the year 0 ($\Delta ao_i^* = ao_i - ao_0$), *% of GDP*; $\Delta\delta_i^*$ – change in the deviation of the change in state debt from the amount of debt financing of Ukraine's budget in year i relative to the year 0 ($\Delta\delta_i^* = \delta_i - \delta_0$), *% of GDP*.

The *value of annual adjustment of adjusted primary balance of Ukraine's budget* (c^a) is calculated by formula (12). Formula (12) is obtained by equating the right-hand side of formula (10) to the right-hand side of formula (11):

$$c^a = \frac{\text{б}_0 \cdot \prod_{t=1}^{T} \frac{1+r_t}{1+\gamma_t} - \text{б}_T - (nc_0 + np_0 + ao_0 - \delta_0) \cdot \sum_{i=1}^{T} \prod_{t=i+1}^{T} \frac{1+r_t}{1+\gamma_t}}{(k_2 - k_1 + 1) \cdot \sum_{i=k_1}^{T} \prod_{t=i+1}^{T} \frac{1+r_t}{1+\gamma_t} - \sum_{i=k_1}^{k_2} \left((k_2 - i) \cdot \prod_{t=i+1}^{T} \frac{1+r_t}{1+\gamma_t} \right)} +$$

$$+ \left(- \frac{\sum_{i=1}^{T} \left(\left(\Delta nc_i^* + \Delta np_i^* + \Delta ao_i^* - \Delta\delta_i^* \right) \cdot \prod_{t=i+1}^{T} \frac{1+r_t}{1+\gamma_t} \right)}{(k_2 - k_1 + 1) \cdot \sum_{i=k_1}^{T} \prod_{t=i+1}^{T} \frac{1+r_t}{1+\gamma_t} - \sum_{i=k_1}^{k_2} \left((k_2 - i) \cdot \prod_{t=i+1}^{T} \frac{1+r_t}{1+\gamma_t} \right)} \right). \quad (12)$$

The *adapted long-term fiscal sustainability indicator* $S2^a$ is calculated by the formula of its decomposition (13):

$$S2^a = \underbrace{\frac{\text{б}_0}{\sum_{i=1}^{\infty} \prod_{t=1}^{i} \frac{1+\gamma_t}{1+r_t}} - (nc_0 + np_0 + ao_0 - \delta_0)}_{Component1} + \quad (13)$$

$$+ \underbrace{\left(- \frac{\sum_{i=1}^{\infty} \left(\left(\Delta nc_i^* + \Delta np_i^* + \Delta ao_i^* - \Delta\delta_i^* \right) \prod_{t=1}^{i} \frac{1+\gamma_t}{1+r_t} \right)}{\sum_{i=1}^{\infty} \prod_{t=1}^{i} \frac{1+\gamma_t}{1+r_t}} \right)}_{Component2},$$

where $S2^a$ – long-term fiscal sustainability indicator adapted to the government finance statistics of Ukraine, *% of GDP*.

Adapted formulas of fiscal sustainability indicators $S1^a$ and $S2^a$ differ from analogous formulas of European indicators $S1$ and $S2$ in that they use the variable of the *adjusted primary balance* of budget in *relative* value ($пс+пр+ао-\delta$) instead of the variable of the *primary balance* of budget in *relative* value ($пс$).

Formulas of *adapted budget constraints* (one-period budget constraint in relative variables, budget constraint for a final period of time, intertemporal budget constraint), as well as formulas of *adapted fiscal sustainability indicators* $S1^a$ and $S2^a$ are given in Table A.1 of Annex A together with their *European* analogues.

In order **to take into account the currency structure of state debt in the formulas of adapted fiscal sustainability indicators**, it is necessary to make respective changes to the formula of *adapted one-period budget constraint in absolute variables* (9).

The currency structure of Ukraine's state debt can be expressed through the *share of state debt denominated in national currency* ($\alpha_{t-1}^{н}$):

$$Б_{t-1} = \underbrace{\alpha_{t-1}^{н} \cdot Б_{t-1}}_{\substack{\text{state debt}\\ \text{denominated}\\ \text{in national currency}}} + \underbrace{\left(1-\alpha_{t-1}^{н}\right) Б_{t-1}}_{\substack{\text{state debt}\\ \text{denominated}\\ \text{in foreign currency}}},$$

where $Б_{t-1}$ – state debt of Ukraine at the end of year ($t-1$), in hrivnia equivalent, *units of national currency*; $\alpha_{t-1}^{н}$ – share of Ukraine's state debt denominated in national currency in year ($t-1$), *coefficient*; $\left(1-\alpha_{t-1}^{н}\right)$ – share of Ukraine's state debt denominated in foreign currency in year ($t-1$), *coefficient*.

The currency structure of expenditures of the Ukraine's State Budget on Ukraine's state debt servicing ($r_t \cdot Б_{t-1}$) can be expressed similarly as:

$$r_t \cdot Б_{t-1} = \underbrace{r_t^{н} \cdot \alpha_{t-1}^{н} \cdot Б_{t-1}}_{\substack{\text{expenditutes on state debt}\\ \text{servicing denominated}\\ \text{in national currency}}} + \underbrace{r_t^{ін} \cdot \left(1-\alpha_{t-1}^{н}\right) Б_{t-1}}_{\substack{\text{expenditutes on state debt}\\ \text{servicing denominated}\\ \text{in foreign currency}}}, \quad (14)$$

where r_t – effective nominal interest rate on Ukraine's state debt in year t, annual, *coefficient*; $r_t^{н}$ – effective nominal interest rate on Ukraine's state debt denominated in national currency in year t, annual, *coefficient*; $r_t^{ін}$ – effective nominal interest rate on Ukraine's state debt denominated in foreign currency in year t, annual, *coefficient*.

After substituting formula (14) into the *adapted one-period budget constraint in absolute variables* (formula (9)) and some algebraic transformations, we obtain formula (15):

$$Б_t - Б_{t-1} = \underbrace{\left(r_t^{ін} + \alpha_{t-1}^{н} \cdot \left(r_t^{н} - r_t^{ін}\right)\right)}_{\substack{\text{adjusted effective nominal}\\ \text{interest rate on the state debt}}} \cdot Б_{t-1} - \underbrace{\left(ПС_t + Пр_t + АО_t - \Delta_t\right)}_{\substack{\text{adjusted primary balance}\\ \text{of budget}}}. \quad (15)$$

Formula (15) is the *adapted one-period budget constraint in absolute variables, which takes into account the currency structure* of Ukraine's state debt.

The *adapted one-period budget constraint in absolute variables, which takes into account the currency structure* of Ukraine's state debt (formula (15)), differs from such budget constraint, which does not take into account the currency structure of Ukraine's state debt (formula (9)), in that it uses the *adjusted effective nominal interest rate* on the state debt ($r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)$) instead of the *effective nominal interest rate* on the state debt (r_t).

The chain of algebraic transformations from the *adapted one-period budget constraint in absolute variables, which takes into account the currency structure* of state debt, to the *adapted fiscal sustainability indicators* $S1^{ав}$ and $S2^{ав}$, *which take into account the currency structure* of state debt, will be the same as that of their European analogues [19, p. 36–45].

The *adapted medium-term fiscal sustainability indicator, taking into account the currency structure of state debt* $S1^{ав}$, is calculated either by formula (16) or by the formula of its decomposition (17):

$$S1^{ав}=c^{ав}\cdot\left(k_2-k_1+1\right), \tag{16}$$

$$\begin{aligned}
S1^{ав}= & \frac{б_0\cdot\left(\prod\limits_{t=1}^{T}\frac{1+r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)}{1+\gamma_t}-1\right)}{\sum\limits_{i=k_1}^{T}\prod\limits_{t=i+1}^{T}\frac{1+r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)}{1+\gamma_t}}- \\
& -\left(nc_0+np_0+ao_0-\delta_0\right)\cdot\frac{\sum\limits_{i=1}^{T}\prod\limits_{t=i+1}^{T}\frac{1+r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)}{1+\gamma_t}}{\sum\limits_{i=k_1}^{T}\prod\limits_{t=i+1}^{T}\frac{1+r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)}{1+\gamma_t}}+ \\
& +\underbrace{\frac{б_0-б_T}{\sum\limits_{i=k_1}^{T}\prod\limits_{t=i+1}^{T}\frac{1+r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)}{1+\gamma_t}}}_{Component\,2}+ \\
& +\underbrace{\left(-\frac{\sum\limits_{i=1}^{T}\left(\left(\Delta nc_i^*+\Delta np_i^*+\Delta ao_i^*-\Delta\delta_i^*\right)\cdot\prod\limits_{t=i+1}^{T}\frac{1+r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)}{1+\gamma_t}\right)}{\sum\limits_{i=k_1}^{T}\prod\limits_{t=i+1}^{T}\frac{1+r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)}{1+\gamma_t}}\right)}_{Component\,3}+ \\
& +\underbrace{c^{ав}\cdot\frac{\sum\limits_{i=k_1}^{k_2}\left(\left(k_2-i\right)\cdot\prod\limits_{t=i+1}^{T}\frac{1+r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)}{1+\gamma_t}\right)}{\sum\limits_{i=k_1}^{T}\prod\limits_{t=i+1}^{T}\frac{1+r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)}{1+\gamma_t}}}_{Component\,4}
\end{aligned} \tag{17}$$

where $S1^{ав}$ – adapted medium-term fiscal sustainability indicator, taking into account the currency structure of Ukraine's state debt, *% of GDP*; $c^{ав}$ – the value of annual adjustment of *adjusted primary* balance of Ukraine's budget ($nc+np+ao-\delta$) during $[k_1;k_2]$ ($[k_1;k_2]\subset[1;T]$), taking into account the currency structure of Ukraine's state debt, *% of GDP*; k_1 – first year of the annual adjustments period; k_2 – last year of the annual adjustments period; $б_0$ – state debt of Ukraine at the end of year 0, *% of GDP*; $б_T$ – state debt of Ukraine at the end of year T, *% of GDP*; $r_t^{ін}$ – effective nominal interest rate on Ukraine's state debt denominated in foreign currency in year t, annual, *coefficient*; $r_t^{н}$ – effective nominal interest rate on Ukraine's state debt denominated in national currency in year t, annual, *coefficient*; $\alpha_{t-1}^{н}$ – share of state debt denominated in national currency in year ($t-1$), *coefficient*; γ_t – nominal GDP growth rate in year t, *coefficient*; nc_0 – primary balance of Ukraine's budget in year 0, *% of GDP*; np_0 – amount of financing of Ukraine's budget from state property privatization in year 0, *% of GDP*; ao_0 – amount of financing of Ukraine's budget from active transactions in year 0, *% of GDP*; δ_0 – the value, by which the change in state debt deviates from the amount of debt financing of Ukraine's budget in year 0, *% of GDP*; Δnc_i^* – change in the primary balance of Ukraine's budget in year i relative to the year 0 ($\Delta nc_i^*=nc_i-nc_0$), *% of GDP*; Δnp_i^* – change in the amount of financing of Ukraine's budget from state property privatization in year i relative to the year 0 ($\Delta np_i^*=np_i-np_0$), *% of GDP*; Δao_i^* – change in the amount of financing of Ukraine's budget from active transactions in year i relative to the year 0 ($\Delta ao_i^*=ao_i-ao_0$), *% of GDP*; $\Delta\delta_i^*$ – change in the deviation of the change in state debt from the amount of debt financing of Ukraine's budget in year i relative to the year 0 ($\Delta\delta_i^*=\delta_i-\delta_0$), *% of GDP*.

The *value of the annual adjustment of the adjusted primary balance of Ukraine's budget* in the case of taking into account the *currency structure* of the Ukraine's state debt ($c^{ав}$) is calculated by formula (18):

$$
\begin{aligned}
c^{ав} = {} & \frac{б_0\cdot\prod_{t=1}^{T}\frac{1+r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)}{1+\gamma_t}-б_T}{(k_2-k_1+1)\cdot\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)}{1+\gamma_t}-\sum_{i=k_1}^{k_2}\left((k_2-i)\cdot\prod_{t=i+1}^{T}\frac{1+r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)}{1+\gamma_t}\right)}+ \\
& +\left(-\frac{(nc_0+np_0+ao_0-\delta_0)\cdot\sum_{i=1}^{T}\prod_{t=i+1}^{T}\frac{1+r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)}{1+\gamma_t}}{(k_2-k_1+1)\cdot\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)}{1+\gamma_t}-\sum_{i=k_1}^{k_2}\left((k_2-i)\cdot\prod_{t=i+1}^{T}\frac{1+r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)}{1+\gamma_t}\right)}\right)+ \\
& +\left(-\frac{\sum_{i=1}^{T}\left(\left(\Delta nc_i^*+\Delta np_i^*+\Delta ao_i^*-\Delta\delta_i^*\right)\cdot\prod_{t=i+1}^{T}\frac{1+r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)}{1+\gamma_t}\right)}{(k_2-k_1+1)\cdot\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)}{1+\gamma_t}-\sum_{i=k_1}^{k_2}\left((k_2-i)\cdot\prod_{t=i+1}^{T}\frac{1+r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)}{1+\gamma_t}\right)}\right).
\end{aligned}
\qquad (18)
$$

The *adapted long-term fiscal sustainability indicator, which takes into account the currency structure of state debt* $S2^{ав}$, is calculated by the formula of its decomposition (19):

$$S2^{ав} = \underbrace{\frac{б_0}{\sum_{i=1}^{\infty}\prod_{t=1}^{i}\frac{1+\gamma_t}{1+r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)}} - \left(nc_0+np_0+ao_0-\delta_0\right)}_{Component\,1} +$$

$$+\underbrace{\left(-\frac{\sum_{i=1}^{\infty}\left(\left(\Delta nc_i^{*}+\Delta np_i^{*}+\Delta ao_i^{*}-\Delta\delta_i^{*}\right)\prod_{t=1}^{i}\frac{1+\gamma_t}{1+r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)}\right)}{\sum_{i=1}^{\infty}\prod_{t=1}^{i}\frac{1+\gamma_t}{1+r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)}}\right)}_{Component\,2}, \qquad (19)$$

where $S2^{ав}$ – adapted long-term fiscal sustainability indicator, taking into account the currency structure of Ukraine's state debt, *% of GDP*.

Formulas of adapted medium-term and long-term fiscal sustainability indicators, which take into account the currency structure of Ukraine's state debt $S1^{ав}$ and $S2^{ав}$, respectively, differ from those, which do not take into account the currency structure of Ukraine's state debt $S1^{a}$ and $S2^{a}$, respectively, in that they use the *adjusted effective nominal interest rate* on the state debt $\left(r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)\right)$ instead of the *effective nominal interest rate* on the state debt (r_t).

Formulas of *adapted budget constraints taking into account the currency structure* of Ukraine's state debt (one-period budget constraint in relative variables, budget constraint for a final period of time, intertemporal budget constraint), as well as formulas of *adapted fiscal sustainability indicators taking into account the currency structure* of Ukraine's state debt $S1^{ав}$ and $S2^{ав}$ are given in Table A.1 of Annex A together with their *adapted* analogues, which *do not take into account the currency structure* of Ukraine's state debt, and *European* analogues.

Calculations based on retrospective data confirm that the *adapted* formulas of *medium-term* fiscal sustainability indicators, which *do not take into account* and which *take into account the currency structure* of Ukraine's state debt ($S1^{a}$ and $S1^{ав}$, respectively), as well as formulas of their variables c^{a} and $c^{ав}$ are well-formed. If the values of the indicators $S1^{a}$ and $S1^{ав}$ are equal to zero, then the respective formulas are correct.

Retrospective data of budget reporting (see Table B.1 of Annex B) are balanced and indicate that the state has successfully solved the issue of solvency. In mathematical language, this means that all budget constraints of past periods (one-period budget constraints in absolute and relative variables, budget constraint for a finite period of time) are met, and as a result, the values of indicators $S1^{a}$ and $S1^{ав}$ over past periods are equal to zero.

As calculations show, for random intervals from the period 2006–2018, the values of indicator $S1^{a}$ calculated by formulas (10), (12) and indicator $S1^{ав}$ calculated by formulas (16), (18) are equal to zero. Therefore, the respective formulas of these indicators are well-formed.

Based on retrospective data, it is impossible to verify that the *adapted* formulas of *long-term* fiscal sustainability indicators, which *do not take into account* and which *take into account the currency structure* of Ukraine's state debt $S2^{a}$ and $S2^{ав}$ (formulas (13) and (19), respectively), are well-formed, as is done for *medium-term* fiscal sustainability indicators $S1^{a}$ and $S1^{ав}$, because an infinite period, for which the values of indicators $S1^{a}$ and $S1^{ав}$ are calculated, extends beyond the end of the finite period of retrospective data.

The fact that adapted formulas of *long-term* fiscal sustainability indicators $S2^{a}$ and $S2^{ав}$ are well-formed follows from the fact that adapted formulas of *medium-term* fiscal sustainability indicators $S1^{a}$ and $S1^{ав}$ are well-formed, because the adaptation of formulas of indicators $S2^{a}$ and $S2^{ав}$ to Ukrainian government finance statistics was carried out on the same basis as adaptation of the formulas of indicators $S1^{a}$ and $S1^{ав}$.

Retrospective data show how wrong the use of European formulas of fiscal sustainability indicators is in the case, where government finance statistics are compiled according to the Ukrainian methodology in accordance with the 1986 IMF's Government Finance Statistics Manual (see Table 1).

Table 1

The value of indicator $S1$ for the period $[t_1; t_T] \in [2006; 2018]$, *% of GDP*

Base year, (t_0)	Level of state debt at the end of the base year, $б_{t_0}$	First year of the medium-term period, t_1 \ t_T	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
		Level of state debt at the end of the last year of the medium-term period, $б_{t_T}$	11,7	9,5	13,2	24,0	28,9	26,5	27,4	31,5	59,7	67,1	69,2	61,5	52,3
2005	13,8	2006	0,1	0,4	–1,7	–3,0	–3,0	–2,5	–1,9	–1,8	–4,5	–6,0	–6,6	–6,3	–5,4
2006	11,7	2007	–	0,6	–2,4	–3,7	–3,5	–2,9	–2,1	–2,0	–4,9	–6,5	–7,0	–6,6	–5,7
2007	9,5	2008	–	–	–4,7	–5,5	–4,6	–3,5	–2,6	–2,3	–5,5	–7,1	–7,6	–7,2	–6,1
2008	13,2	2009	–	–	–	–6,4	–4,6	–3,2	–2,1	–1,9	–5,6	–4,5	–7,9	–7,4	–6,2
2009	24,0	2010	–	–	–	–	–2,9	–1,8	–0,9	–0,9	–5,5	–7,6	–8,1	–7,5	–6,2
2010	28,9	2011	–	–	–	–	–	–0,8	0,0	–0,3	–6,1	–8,4	–8,8	–8,0	–6,5
2011	26,5	2012	–	–	–	–	–	–	0,8	–0,1	–7,9	–10,4	–10,4	–9,1	–7,2
2012	27,4	2013	–	–	–	–	–	–	–	–1,1	–12,5	–14,2	–13,1	–10,9	–8,3
2013	31,5	2014	–	–	–	–	–	–	–	–	–24,5	–20,6	–16,8	–13,0	–9,5
2014	59,7	2015	–	–	–	–	–	–	–	–	–	–17,2	–13,6	–10,1	–6,8
2015	67,1	2016	–	–	–	–	–	–	–	–	–	–	–10,3	–7,2	–4,1
2016	69,2	2017	–	–	–	–	–	–	–	–	–	–	–	–4,5	–1,7
2017	61,5	2018	–	–	–	–	–	–	–	–	–	–	–	–	0,9

Note: (–) – data are not calculated.
Source: author's calculations.

Values of indicator $S1$ in Table 1 are calculated by the European formulas (A.4)–(A.5) (see Table A.1 of Annex A) based on retrospective data for 2005–2018, compiled according to the Ukrainian methodology in accordance with the 1986 IMF's Government Finance Statistics Manual (see Table B.1 of Annex B). It was assumed that the adjustment of the primary balance of the Ukraine's State Budget is one-off ($k_2 - k_1 + 1 = 1$) and is carried out in the first year of the medium-term period ($k_1 = k_2 = t_1$). The calculations cover all possible time periods ($[2006; 2006]$,

$[2006;2007]$, …, $[2006;2018]$, $[2007;2007]$, $[2007;2008]$, …, $[2007;2018]$, …, $[2018;2018]$).

All values of indicator $S1$ in Table 1 are not equal to zero. In the predominant number of cases, they are negative ($S1<0$).

According to the interpretation of the calculation results, in periods when the values of indicator $S1$ are negative, the budget is sustainable. And not just sustainable, but also has a margin of ‘safety' in an amount equal to the absolute value of the negative indicator $S1$. This means that in such periods the primary balance of the Ukraine's State Budget could *be worsened* without losing the solvency of the state by the absolute value of the negative indicator $S1$ (pursuing a ‘looser' fiscal policy).

A worsening of the primary balance of budget is an *increase* in the primary *deficit* of budget in the case, where the primary balance of budget is negative, or a *reduction* of the primary *surplus* of budget or a transition to a primary *deficit* of budget in the case, where the primary balance of budget is positive.

The worsening of the primary balance of budget is achieved either by *reducing* budget *revenues*, for example, by reducing tax rates, or by *increasing* budget *expenditures*, or a combination of the two.

Thus, given the value of the indicator calculated according to the European formula ($S1<0$) (see Table 1), we could speak about the possibility of increasing the level of financing for expenditures in 2006-2018, and the possibility of reducing the tax burden on economic entities in this period, and the excess borrowing, and so on.

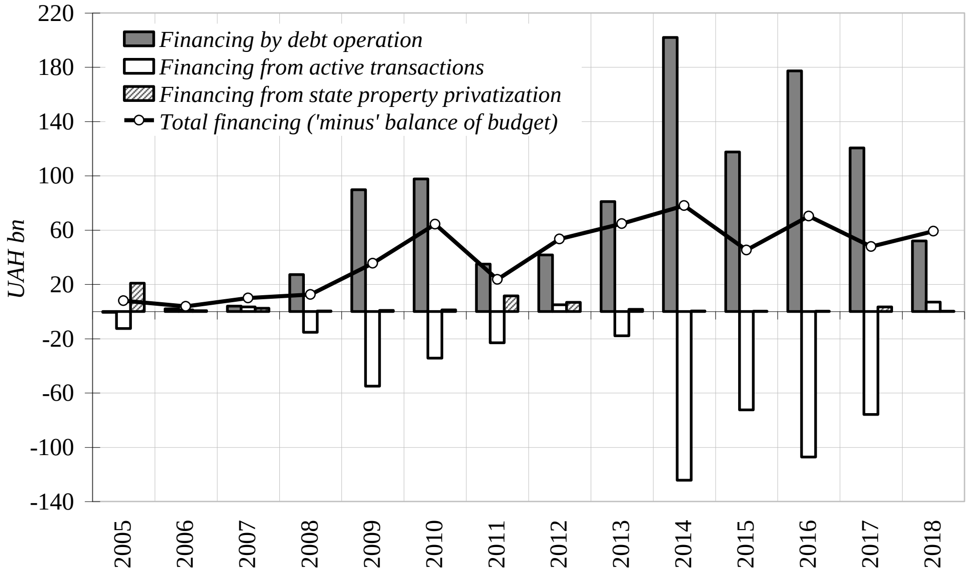
That is, the use of the European formula of the medium-term fiscal sustainability indicator $S1$ on data compiled according to the Ukrainian methodology in accordance with the 1986 IMF's Government Finance Statistics Manual, in most cases significantly *improved* Ukraine's solvency assessment in 2006-2018 compared to such assessment based on the adapted formula of indicator $S1^a$ ($S1<0$, while $S1^a=0$).

Graph 1 visually helps to reveals, why this happened.

Recall that the amount of *debt financing* of the budget is approximately equal to the *change in state debt*, and the amount of *total financing* of budget is equal to the *balance* of the budget, taken with the opposite sign.

Graph 1 shows that the amount of debt financing of the Ukraine's State Budget (change in Ukraine's state debt) is not equal to the total financing of the Ukraine's State Budget (balance of the Ukraine's State Budget, taken with the opposite sign), as required by the European version of one-period budget constraint in absolute variables (formula (2)). That is, the European one-period budget constraint in absolute variables in the case of using variables compiled according to the Ukrainian methodology is not met. Thus, in each year during 2005–2018 there are fiscal gaps. And, as shown by the calculations of the European indicator $S1$ ($S1\neq 0$) (see Table 1), they remain for longer periods.

As shown in Graph 1, the amount of debt financing of the Ukraine's State Budget (change in Ukraine's state debt) is equal to the difference between the amount of total financing of the Ukraine's State Budget (balance of the Ukraine's State Budget, taken with the opposite sign) and the amount of non-debt financing of the Ukraine's State Budget (the amount of financing from state property privatization and the amount of financing from active transactions), as required by the adapted one-period budget constraint in absolute variables (formula (8)). In other words, the amount of debt financing of the Ukraine's State Budget (change in Ukraine's state debt) is equal to the sum of the balance of the Ukraine's State Budget and the amount of non-debt financing of the Ukraine's State Budget, taken with the opposite sign. That is, the adapted one-period budget constraint in absolute variables is met annually. Thus, in 2005–2018, there are no annual fiscal gaps. And, as confirmed by retrospective calculations of adapted indicators $S1^{a}$ and $S1^{aв}$ ($S1^{a}=0, S1^{aв}=0$), there are no budget gaps for longer periods either.



Graph 1. Financing of the Ukraine's State Budget by sources of financing

Source: constructed by the author according to data of the State Treasury Service of Ukraine, namely: 'Section IV.2. Financing by classification of budget financing by type of debt liability' of the annual report on the execution of the Ukraine's State Budget [21].

Interpreting the results of the calculation of the adapted medium-term fiscal sustainability indicator, which takes into account the currency structure of Ukraine's state debt $S1^{aв}$, it is necessary to consider it together with the adapted medium-term fiscal sustainability indicator, which does not take into account the currency structure of Ukraine's state debt $S1^{a}$.

If the variables common to both indicators (γ_t, $б_0$, $б_T$, nc_0, np_0, ao_0, δ_0, T, k_1, k_2) have the same values, the difference between the value of indicator $S1^{aв}$ and the value of indicator $S1^{a}$ ($S1^{aв}-S1^{a}$) shows the value of additional adjustment of budget expenditures on servicing of Ukraine's state debt, required to that in the medium-term period such expenditures correspond to the target currency structure of Ukraine's state debt.

As retrospective calculations for 2005–2018 showed, with the shift of the currency structure of Ukraine's state debt towards an increase in its share denominated in national currency ($\alpha_t^{н}$), the value of additional adjustment of budget expenditures on servicing of Ukraine's state debt ($S1^{ав} - S1^{a}$) increases from 0% of GDP to 0.46% of GDP, and with a shift in the currency structure of Ukraine's state debt towards a decrease in its share denominated in national currency, the value of additional adjustment of budget expenditures on servicing of Ukraine's state debt ($S1^{ав} - S1^{a}$) decreases from 0% of GDP to (-0.23)% of GDP (see Table 2). This fact has a logical explanation: since 2009 the value of effective nominal interest rate on Ukraine's state debt denominated in national currency ($r_t^{н}$), significantly exceeded the value of effective nominal interest rate on Ukraine's state debt denominated in foreign currency ($r_t^{ін}$), (see columns 17 and 18 of Table B.1 of Annex B).

Calculations of indicator values $S1^{a}$ (according to formulas (10), (12)) and $S1^{ав}$ (according to formulas (16), (18)) in table 2 was made for the *baseline* scenario of the formation of the currency structure of Ukraine's state debt in 2005–2018, which is based on retrospective data of Ukraine for 2005–2018, and *Scenarios 1–4* of the formation of the currency structure of Ukraine's state debt in 2005–2018.

Under the *baseline* scenario, the initial (base or zero) year is 2005. The medium-term period lasts 13 years (2006–2018) ($T = 13$). Adjustment of the adjusted primary balance of the Ukraine's State Budget takes place one-off ($k_2 - k_1 + 1 = 1$) in the first year of the medium-term period (2006) ($k_1 = k_2 = 1$).The initial values of Ukraine's state debt and the adjusted primary balance of Ukraine's budget are set at the level of 2005, namely: 13.8% of GDP ($б_0 = 13{,}8$) and 1.6% of GDP $\widetilde{nc}_0 = nc_0 + np_0 + ao_0 - \delta_0 = (-1{,}1) + 4{,}5 + (-2{,}7) - (-0{,}9) = 1{,}6$) (see columns 5 and 36 of Table B.1of Annex B, respectively). Values of the nominal GDP growth rate (γ_t) are equal to the data in column 3 of Table. B.1, divided by 100%; values of the effective nominal interest rate on Ukraine's state debt (r_t) – data in column 16 of Table B.1, divided by 100%; values of effective nominal interest rates on Ukraine's state debt, denominated in national currency and foreign currency ($r_t^{н}$ and $r_t^{ін}$, respectively), – data in columns 17 and 18, respectively, Table B.1, divided by 100%; values of the share of Ukraine's state debt denominated in national currency ($\alpha_t^{н}$), – data in column 20 of Table B.1, divided by 100%. Changes in the adjusted primary balance of Ukraine's budget relative to 2005 $\left(\Delta\widetilde{nc}_t^{*} = \Delta nc_t^{*} + \Delta np_t^{*} + \Delta ao_t^{*} - \Delta\delta_t^{*} = (nc_t + np_t + ao_t - \delta_t) - (nc_0 + np_0 + ao_0 - \delta_0)\right)$ are calculated based on the data in column 36 of Table B.1.

Under Scenarios 1–4, all conditions and variables, except for the currency structure of Ukraine's state debt, remain the same as under the baseline scenario.

Scenario 1 assumes that the share of Ukraine's state debt denominated in national currency ($\alpha_t^{н}$) decreases annually by 0.415%: from 30.4% at the end of 2005 to 25.0% at the end of 2018 (25.0% is the lowest value of the share over the period 2006–2018) (see Table 2).

Under Scenario 2, the share of Ukraine's state debt denominated in national currency ($\alpha_t^{н}$) remains at the level of 2005 (30.4%) during the medium-term period.

Under Scenario 3, the share of Ukraine's state debt denominated in national currency ($\alpha_t^н$) at the end of the medium-term period is 50%, increasing annually by 1.51% starting from 30.4% in 2005.

Table 2

The value of Indicator $S1^{ав}$ depending on the currency structure of Ukraine's state debt

		Scenario 1	**Scenario 2**	**Baseline scenario**	**Scenario 3**	**Scenario 4**
Share of Ukraine's state debt denominated in national currency by years, % ($\alpha_t^н$)	2005	30,4	30,4	30,4	30,4	30,4
	2006	30,0	30,4	25,1	31,9	33,4
	2007	29,6	30,4	25,0	33,4	36,4
	2008	29,1	30,4	34,2	34,9	39,4
	2009	28,7	30,4	40,1	36,4	42,5
	2010	28,3	30,4	43,8	37,9	45,5
	2011	27,9	30,4	44,3	39,4	48,5
	2012	27,5	30,4	41,6	41,0	51,5
	2013	27,1	30,4	42,9	42,5	54,5
	2014	26,7	30,4	40,2	44,0	57,6
	2015	26,2	30,4	32,4	45,5	60,6
	2016	25,8	30,4	33,2	47,0	63,6
	2017	25,4	30,4	34,4	48,5	66,6
	2018	25,0 *minimum level over 2005-2018*	30,4 *level in 2005.*	33,5 *actual level*	50,0 *half of Ukraine's state debt*	69,6 *level of the share of Ukraine's state debt denominated in foreign currency in 2005*
Average annual change in the share of Ukraine's state debt denominated in national currency, %		-0,415	0	actual values	1,510	3,020
Indicator $S1^{ав}$, % of GDP		**-0,23**	**-0,14**	**0,0**	**0,17**	**0,46**
Indicator $S1^{а}$, % of GDP		**0,0**				
Value of additional adjustment of the primary balance of the Ukraine's State Budget, namely: expenditures on servicing of Ukraine's state debt ($S1^{ав} - S1^{а}$), % of GDP		**-0,23**	**-0,14**	**0,0**	**0,17**	**0,46**

Source: author's calculations.

Scenario 4 assumes that at the end of 2018 the share of Ukraine's state debt denominated in national currency ($\alpha_t^н$) will be the same as the share of Ukraine's state debt denominated in foreign currency at the end of 2005 (69.6%). That is, the share of Ukraine's state debt denominated in national currency ($\alpha_t^н$) will increase annually by 3.02% starting from 30.4% in 2005.

The shift of the currency structure of Ukraine's state debt towards increasing its share denominated in national currency ($\alpha_t^н$) and accordingly reducing its share denominated in foreign currency, as Scenarios 3 and 4 assume, would require an increase in expenditures of the Ukraine's State Budget on servicing of Ukraine's state debt in the amount of 0.17% of GDP and 0.46% of GDP, respectively ($S1^{ав}-S1^{а}=0.17$ and $S1^{ав}-S1^{а}=0.46$, respectively) in each year of the medium-term period (from 2005 to 2018).

The shift of the currency structure of Ukraine's state debt towards reducing its share denominated in national currency ($\alpha_t^{н}$) and, accordingly, increasing its share denominated in foreign currency, as Scenarios 1 and 2 assume, on the contrary, would save expenditures of Ukraine's State Budget on servicing of Ukraine's state debt in the amount of 0.23% of GDP and 0.14% of GDP, respectively ($S1^{ав}-S1^{а}=-0.23$ and $S1^{ав}-S1^{а}=-0.14$, respectively) in each year of the medium-term period (from 2005 to 2018).

Thus, the *adapted* medium-term and long-term fiscal sustainability indicators ($S1^{а}$, $S1^{ав}$ and $S2^{а}$, $S2^{ав}$) are a well-formed and effective tool for assessing Ukraine's solvency in conditions when the country's government finance statistics are compiled according to outdated methodology in accordance with the *1986* IMF's *Government Finance Statistics Manual*, and the currency structure of state debt significantly affects the solvency of the state.

The use of adapted formulas of fiscal sustainability indicators enables to tackle a number of problems. First, to get rid of wrong estimates of Ukraine's solvency, which are obtained when using the European formulas of fiscal sustainability indicators, tied to the variables of government finance statistics, and compiled according to the methodology of the *European System of National and Regional Accounts 2010*. Secondly, to assess the value by which the expenditures of the Ukraine's State Budget on servicing of Ukraine's state debt will change when the currency structure of the Ukraine's state debt changes.

The use of adapted formulas of fiscal sustainability indicators also raises new problems that need to be tackled.

The adapted formulas of fiscal sustainability indicators include a variable of the *deviation of the change in Ukraine's state debt from the amount of debt financing of the budget* (δ_t). During the years of sharp hikes of the official price of the US dollar – in 2014–2015 (from UAH 8 per US dollar at the end of 2013 to UAH 16 per US dollar at the end of 2014, and then up to UAH 24 per US dollar at the end of 2015), – its values reached 17% of GDP and 14% of GDP, respectively, while in the years of relatively stable exchange rate – in 2010–2013 – they were about 0% of GDP (see columns 29-30 of Table B.1 of Annex B).

The variable of *deviation of the change in Ukraine's state debt from the amount of debt financing of the budget* (δ_t) accumulates the impact of exchange rate changes on Ukraine's state debt. Its analysis and forecasting require further research.

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Received 15.11.19
Reviewed 09.12.19
Signed for print 15.02.20

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ОСОБЛИВОСТІ ПОБУДОВИ ІНДИКАТОРІВ БЮДЖЕТНОЇ СТІЙКОСТІ В УКРАЇНІ

Для оцінювання бюджетної стійкості Європейська Комісія використовує індикатори середньострокової та довгострокової бюджетної стійкості $S1$ та $S2$. Показники у формулах цих індикаторів формуються за методологією Європейської системи національних та регіональних рахунків 2010 р. згідно з Керів-ництвом Євростату з державного дефіциту та боргу. Україна формує статистику державних фінансів відповідно до Керівництва МВФ зі статистики державних фінансів у редакції 1986 р. Однойменні показники статистики державних фінансів, сформовані за різними методологіями, мають різне охоплення даних. Тому в Україні не можна беззастережно використовувати формули індикаторів бюджетної стійкості $S1$ та $S2$, показники яких формуються за європейською методологією. У статті індикатори бюджетної стійкості $S1$ та $S2$ адаптовано до статистики державних фінансів, сформованої за українською методологією. Адаптовані індикатори середньострокової та довгострокової бюджетної стійкості $S1^a$ та $S2^a$ відрізняються від своїх європейських аналогів тим, що в них замість показника первинного сальдо бюджету використовується показник скоригованого первинного сальдо бюджету. Побудовано адаптовані індикатори середньострокової та довгострокової бюджетної стійкості $S1^{ав}$ та $S2^{ав}$, які враховують валютну структуру державного боргу. Останні відрізняються від адаптованих індикаторів $S1^a$ та $S2^a$, що не враховують валютну структуру державного боргу, тим, що в них замість фактичної номінальної процентної ставки обслуговування державного боргу використовується скоригована фактична номінальна процентна ставка обслуговування державного боргу. Різниця між адаптованими середньостроковими індикаторами бюджетної стійкості, що враховують та не враховують валютну структуру державного боргу ($S1^{ав}-S1^a$), а також різниця між адаптованими довгостроковими індикаторами бюджетної стійкості, що враховують та не враховують валютну структуру державного боргу ($S2^{ав}-S2^a$) показують величини, на які додатково потрібно скоригувати видатки бюджету на обслуговування державного боргу для того, щоб такі видатки відповідали цільовій валютній структурі державного боргу в середньостроковому та довгостроковому періодах відповідно. На ретроспективних даних статистики державних фінансів України (2005–2018 рр.), сформованої за українською методологією, показано, наскільки хибними є оцінки середньострокової бюджетної стійкості, одержані з використанням європейської формули індикатора середньострокової бюджетної стійкості $S1$, а також обчислено оцінки додаткового коригування видатків Державного бюд-жету України на обслуговування державного боргу України для різних сценаріїв формування валютної структури державного боргу України у 2006–2018 рр..

Публікацію підготовлено за виконання НДР "Стійкість державних фінансів України у довгостроковій перспективі" (№ держреєстрації 0116U008262).

Ключові слова: бюджетний розрив, бюджетна стійкість, індикатори бюд-жетної стійкості, адаптовані індикатори бюджетної стійкості, валютна структура державного боргу

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ОСОБЕННОСТИ ПОСТРОЕНИЯ ИНДИКАТОРОВ БЮДЖЕТНОЙ УСТОЙЧИВОСТИ В УКРАИНЕ

Для оценивания бюджетной устойчивости Европейская Комиссия использует индикаторы среднесрочной и долгосрочной бюджетной устойчивости $S1$ и $S2$. Показатели в формулах этих индикаторов формируются по методологии Европейской системы национальных и региональных счетов 2010 года в соответствии с Руководством Евростата по государственному дефициту и долгу. Украина формирует статистику

государственных финансов в соответствии с Руководством МВФ по статистике государственных финансов в редакции 1986 года. Одноименные показатели статистики государственных финансов, сформированные по разным методологиям, имеют разный охват данных. Поэтому в Украине нельзя безоговорочно использовать формулы индикаторов бюджетной устойчивости $S1$ и $S2$, показатели которых формируются по европейской методологии. В статье индикаторы бюджетной устойчивости $S1$ и $S2$ адаптированы к статистике государственных финансов, сформированной по украинской методологии. Адаптированные индикаторы среднесрочной и долгосрочной бюджетной устойчивости $S1^a$ и $S2^a$ отличаются от своих европейских аналогов тем, что в них вместо показателя первичного сальдо бюджета используется показатель скорректированного первичного сальдо бюджета. Построе-ны адаптированные индикаторы среднесрочной и долгосрочной бюджетной устойчивости $S1^{ав}$ и $S2^{ав}$, которые учитывают валютную структуру государственного долга. Последние учитывают валютную структуру государственного долга и отличаются от адаптированных индикаторов бюджетной устойчивости $S1^a$ и $S2^a$, которые не учитывают валютную структуру государственного долга, тем, что в них вместо фактической номинальной процентной ставки обслуживания государственного долга используется скорректированная фактическая номинальная процентная ставка обслуживания государственного долга. Разница между адаптированными среднесрочными индикаторами, которые учитывают и не учитывают валютную структуру госу-дарственного долга ($S1^{ав} - S1^a$), а также разница между адаптированными долгосрочными индикаторами, которые учитывают и не учитывают валютную структуру государственного долга ($S2^{ав} - S2^a$), показывают величины, на которые дополнительно нужно скорректировать расходы бюджета на обслуживание государственного долга для того, чтобы такие расходы отвечали целевой валютной структуре государственного долга в среднесрочном и долгосрочном периодах соответственно. На ретроспективных данных статистики государственных финансов Украины (2005–2018 гг.), сформированных по украинской методологии, показано, насколько ошибочными являются оценки среднесрочной бюджетной устойчивости, полученные с использованием европейской формулы индикатора среднесрочной бюджетной устойчивости $S1$, а также рассчитаны оценки дополнительного корректирования расходов Государственного бюджета Украины на обслуживание государственного долга Украины для разных сценариев формирования валютной структуры государственного долга Украины в 2006–2018 гг.

Ключевые слова: бюджетный разрыв, бюджетная устойчивость, индикаторы бюджетной устойчивости, валютная структура государственного долга

Annex A

FORMULAS OF BUDGET CONSTRAINTS AND FISCAL SUSTAINABILITY INDICATORS

Table A.1

Formulas of budget constraints and fiscal sustainability indicators expressed in variables of the European and Ukrainian government finance statistics

Formulas expressed in variables of the European government finance statistics	**Adapted formulas expressed in variables of the Ukrainian government finance statistics**	
	without taking into account the currency structure of state debt	taking into account the currency structure of state debt
The one-period budget constraint in relative variables		
$б_{t-1}=\frac{1+\gamma_t}{1+r_t}\cdot б_t+\frac{1+\gamma_t}{1+r_t}\cdot nc_t$ (A.1)	$б_{t-1}=\frac{1+\gamma_t}{1+r_t}\cdot б_t+\frac{1+\gamma_t}{1+r_t}\cdot \widetilde{nc}_t,$ (A.9) where $\widetilde{nc}_t=nc_t+np_t+ao_t-\delta_t$	$б_{t-1}=\frac{1+\gamma_t}{1+\widetilde{r}_t}\cdot б_t+\frac{1+\gamma_t}{1+\widetilde{r}_t}\cdot \widetilde{nc}_t,$ (A.17) where $\widetilde{nc}_t=nc_t+np_t+ao_t-\delta_t$, $\widetilde{r}_t=r_t^{iн}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{iн}\right)$
The budget constraint for a finite period of time		
$б_0=б_T\cdot\prod_{t=1}^{T}\frac{1+\gamma_t}{1+r_t}+\sum_{i=1}^{T}\left(nc_i\cdot\prod_{t=1}^{i}\frac{1+\gamma_t}{1+r_t}\right)$ (A.2)	$б_0=б_T\cdot\prod_{t=1}^{T}\frac{1+\gamma_t}{1+r_t}+\sum_{i=1}^{T}\left(\widetilde{nc}_i\cdot\prod_{t=1}^{i}\frac{1+\gamma_t}{1+r_t}\right),$ (A.10) where $\widetilde{nc}_i=nc_i+np_i+ao_i-\delta_i$	$б_0=б_T\cdot\prod_{t=1}^{T}\frac{1+\gamma_t}{1+\widetilde{r}_t}+\sum_{i=1}^{T}\left(\widetilde{nc}_i\cdot\prod_{t=1}^{i}\frac{1+\gamma_t}{1+\widetilde{r}_t}\right),$ (A.18) where $\widetilde{nc}_i=nc_i+np_i+ao_i-\delta_i$, $\widetilde{r}_t=r_t^{iн}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{iн}\right)$
The intertemporal budget constraint		
$б_0=\sum_{i=1}^{\infty}\left(nc_i\cdot\prod_{t=1}^{i}\frac{1+\gamma_t}{1+r_t}\right)$ (A.3)	$б_0=\sum_{i=1}^{\infty}\left(\widetilde{nc}_i\cdot\prod_{t=1}^{i}\frac{1+\gamma_t}{1+r_t}\right),$ (A.11) where $\widetilde{nc}_i=nc_i+np_i+ao_i-\delta_i$	$б_0=\sum_{i=1}^{\infty}\left(\widetilde{nc}_i\cdot\prod_{t=1}^{i}\frac{1+\gamma_t}{1+\widetilde{r}_t}\right),$ (A.19) where $\widetilde{nc}_i=nc_i+np_i+ao_i-\delta_i$, $\widetilde{r}_t=r_t^{iн}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{iн}\right)$

Continued table A.1

Formulas expressed in variables of the European government finance statistics	Adapted formulas expressed in variables of the Ukrainian government finance statistics	
	without taking into account the currency structure of state debt	taking into account the currency structure of state debt
The annual adjustment of *primary* balance (nc)	The annual adjustment of *adjusted primary* balance ($nc+np+ao-\delta$)	
$c=\frac{\text{б}_0\cdot\prod_{t=1}^{T}\frac{1+r_t}{1+\gamma_t}-\text{б}_T-nc_0\cdot\sum_{i=1}^{T}\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}}{(k_2-k_1+1)\cdot\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}-\sum_{i=k_1}^{k_2}\left((k_2-i)\cdot\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}\right)}+$ (A.4) $+\left(-\frac{\sum_{i=1}^{T}\left(\Delta nc_i^{*}\cdot\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}\right)}{(k_2-k_1+1)\cdot\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}-\sum_{i=k_1}^{k_2}\left((k_2-i)\cdot\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}\right)}\right)$	$c^{a}=\frac{\text{б}_0\cdot\prod_{t=1}^{T}\frac{1+r_t}{1+\gamma_t}-\text{б}_T-\tilde{nc}_0\cdot\sum_{i=1}^{T}\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}}{(k_2-k_1+1)\cdot\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}-\sum_{i=k_1}^{k_2}\left((k_2-i)\cdot\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}\right)}+$ (A.12) $+\left(-\frac{\sum_{i=1}^{T}\left(\Delta\tilde{nc}_i^{*}\cdot\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}\right)}{(k_2-k_1+1)\cdot\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}-\sum_{i=k_1}^{k_2}\left((k_2-i)\cdot\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}\right)}\right),$ where $\tilde{nc}_0=nc_0+np_0+ao_0-\delta_0$, $\Delta\tilde{nc}_i^{*}=\Delta nc_i^{*}+\Delta np_i^{*}+\Delta ao_i^{*}-\Delta\delta_i^{*}$	$c^{\text{ав}}=\frac{\text{б}_0\cdot\prod_{t=1}^{T}\frac{1+\tilde{r}_t}{1+\gamma_t}-\text{б}_T-\tilde{nc}_0\cdot\sum_{i=1}^{T}\prod_{t=i+1}^{T}\frac{1+\tilde{r}_t}{1+\gamma_t}}{(k_2-k_1+1)\cdot\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+\tilde{r}_t}{1+\gamma_t}-\sum_{i=k_1}^{k_2}\left((k_2-i)\cdot\prod_{t=i+1}^{T}\frac{1+\tilde{r}_t}{1+\gamma_t}\right)}+$ (A.20) $+\left(-\frac{\sum_{i=1}^{T}\left(\Delta\tilde{nc}_i^{*}\cdot\prod_{t=i+1}^{T}\frac{1+\tilde{r}_t}{1+\gamma_t}\right)}{(k_2-k_1+1)\cdot\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+\tilde{r}_t}{1+\gamma_t}-\sum_{i=k_1}^{k_2}\left((k_2-i)\cdot\prod_{t=i+1}^{T}\frac{1+\tilde{r}_t}{1+\gamma_t}\right)}\right),$ where $\tilde{nc}_0=nc_0+np_0+ao_0-\delta_0$, $\Delta\tilde{nc}_i^{*}=\Delta nc_i^{*}+\Delta np_i^{*}+\Delta ao_i^{*}-\Delta\delta_i^{*}$, $\tilde{r}_t=r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)$
The indicator of medium-term fiscal sustainability		
$S1=c\cdot(k_2-k_1+1)$, (A.5) where c – see formula (A.4)	$S1^{a}=c^{a}\cdot(k_2-k_1+1)$, (A.13) where c^{a} – see formula (A.12)	$S1^{\text{ав}}=c^{\text{ав}}\cdot(k_2-k_1+1)$, (A.21) where $c^{\text{ав}}$ – see formula (A.20)

Continued table A.1

Formulas expressed in variables of the European government finance statistics	Adapted formulas expressed in variables of the Ukrainian government finance statistics: without taking into account the currency structure of state debt	Adapted formulas expressed in variables of the Ukrainian government finance statistics: taking into account the currency structure of state debt
The decomposition of medium-term fiscal sustainability indicator		
$S1=\underbrace{\frac{\text{б}_0\cdot\left(\prod_{t=1}^{T}\frac{1+r_t}{1+\gamma_t}-1\right)}{\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}}-nc_0\cdot\frac{\sum_{i=1}^{T}\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}}{\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}}}_{Component\,1}+$ (A.6) $+\underbrace{\frac{\text{б}_0-\text{б}_T}{\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}}}_{Component\,2}+\underbrace{\left(-\frac{\sum_{i=1}^{T}\left(\Delta nc_i^*\cdot\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}\right)}{\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}}\right)}_{Component\,3}+$ $\underbrace{+c\cdot\frac{\sum_{i=k_1}^{k_2}\left((k_2-i)\cdot\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}\right)}{\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}}}_{Component\,4},$ where c – see formula (A.4)	$S1^a=\underbrace{\frac{\text{б}_0\cdot\left(\prod_{t=1}^{T}\frac{1+r_t}{1+\gamma_t}-1\right)}{\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}}-\widetilde{nc}_0\cdot\frac{\sum_{i=1}^{T}\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}}{\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}}}_{Component\,1}+$ (A.14) $+\underbrace{\frac{\text{б}_0-\text{б}_T}{\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}}}_{Component\,2}+\underbrace{\left(-\frac{\sum_{i=1}^{T}\left(\Delta\widetilde{nc}_i^*\cdot\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}\right)}{\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}}\right)}_{Component\,3}+$ $\underbrace{+c^a\cdot\frac{\sum_{i=k_1}^{k_2}\left((k_2-i)\cdot\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}\right)}{\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+r_t}{1+\gamma_t}}}_{Component\,4},$ where c^a – see formula (A.12), $\widetilde{nc}_0=nc_0+np_0+ao_0-\delta_0$, $\Delta\widetilde{nc}_i^*=\Delta nc_i^*+\Delta np_i^*+\Delta ao_i^*-\Delta\delta_i^*$	$S1^{ав}=\underbrace{\frac{\text{б}_0\cdot\left(\prod_{t=1}^{T}\frac{1+\tilde{r}_t}{1+\gamma_t}-1\right)}{\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+\tilde{r}_t}{1+\gamma_t}}-\widetilde{nc}_0\cdot\frac{\sum_{i=1}^{T}\prod_{t=i+1}^{T}\frac{1+\tilde{r}_t}{1+\gamma_t}}{\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+\tilde{r}_t}{1+\gamma_t}}}_{Component\,1}+$ (A.22) $+\underbrace{\frac{\text{б}_0-\text{б}_T}{\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+\tilde{r}_t}{1+\gamma_t}}}_{Component\,2}+\underbrace{\left(-\frac{\sum_{i=1}^{T}\left(\Delta\widetilde{nc}_i^*\cdot\prod_{t=i+1}^{T}\frac{1+\tilde{r}_t}{1+\gamma_t}\right)}{\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+\tilde{r}_t}{1+\gamma_t}}\right)}_{Component\,3}+$ $\underbrace{+c^{ав}\cdot\frac{\sum_{i=k_1}^{k_2}\left((k_2-i)\cdot\prod_{t=i+1}^{T}\frac{1+\tilde{r}_t}{1+\gamma_t}\right)}{\sum_{i=k_1}^{T}\prod_{t=i+1}^{T}\frac{1+\tilde{r}_t}{1+\gamma_t}}}_{Component\,4},$ where $c^{ав}$ – see formula (A.20), $\widetilde{nc}_0=nc_0+np_0+ao_0-\delta_0$, $\Delta\widetilde{nc}_i^*=\Delta nc_i^*+\Delta np_i^*+\Delta ao_i^*-\Delta\delta_i^*$, $\tilde{r}_t=r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)$

Continued table A.1

Formulas expressed in variables of the European government finance statistics	Adapted formulas expressed in variables of the Ukrainian government finance statistics	
	without taking into account the currency structure of state debt	taking into account the currency structure of state debt
The decomposition of long-term fiscal sustainability indicator		
$S2=\underbrace{\frac{\text{б}_0}{\sum_{i=1}^{\infty}\prod_{t=1}^{i}\frac{1+\gamma_t}{1+r_t}}}_{Component\,1}-nc_0+\underbrace{\left(-\frac{\sum_{i=1}^{\infty}\left(\Delta nc_i^{*}\cdot\prod_{t=1}^{i}\frac{1+\gamma_t}{1+r_t}\right)}{\sum_{i=1}^{\infty}\prod_{t=1}^{i}\frac{1+\gamma_t}{1+r_t}}\right)}_{Component\,2},$ (A.7)	$S2^{a}=\underbrace{\frac{\text{б}_0}{\sum_{i=1}^{\infty}\prod_{t=1}^{i}\frac{1+\gamma_t}{1+r_t}}}_{Component\,1}-\tilde{nc}_0+\underbrace{\left(-\frac{\sum_{i=1}^{\infty}\left(\Delta \tilde{nc}_i^{*}\cdot\prod_{t=1}^{i}\frac{1+\gamma_t}{1+r_t}\right)}{\sum_{i=1}^{\infty}\prod_{t=1}^{i}\frac{1+\gamma_t}{1+r_t}}\right)}_{Component\,2},$ (A.15) where $\tilde{nc}_0=nc_0+np_0+ao_0-\delta_0$, $\Delta\tilde{nc}_i^{*}=\Delta nc_i^{*}+\Delta np_i^{*}+\Delta ao_i^{*}-\Delta\delta_i^{*}$	$S2^{\text{ав}}=\underbrace{\frac{\text{б}_0}{\sum_{i=1}^{\infty}\prod_{t=1}^{i}\frac{1+\gamma_t}{1+\tilde{r}_t}}}_{Component\,1}-\tilde{nc}_0+\underbrace{\left(-\frac{\sum_{i=1}^{\infty}\left(\Delta \tilde{nc}_i^{*}\cdot\prod_{t=1}^{i}\frac{1+\gamma_t}{1+\tilde{r}_t}\right)}{\sum_{i=1}^{\infty}\prod_{t=1}^{i}\frac{1+\gamma_t}{1+\tilde{r}_t}}\right)}_{Component\,2},$ (A.23) where $\tilde{nc}_0=nc_0+np_0+ao_0-\delta_0$, $\Delta\tilde{nc}_i^{*}=\Delta nc_i^{*}+\Delta np_i^{*}+\Delta ao_i^{*}-\Delta\delta_i^{*}$, $\tilde{r}_t=r_t^{\text{ін}}+\alpha_{t-1}^{\text{н}}\cdot\left(r_t^{\text{н}}-r_t^{\text{ін}}\right)$

Continued table A.1

Formulas expressed in variables of the European government finance statistics	Adapted formulas expressed in variables of the Ukrainian government finance statistics	
	without taking into account the currency structure of state debt	taking into account the currency structure of state debt
The decomposition of long-term fiscal sustainability indicator (formula for the practical use)		
$$S2=\frac{\text{б}_0}{\sum_{i=1}^{N-1}\prod_{t=1}^{i}\frac{1+\gamma_t}{1+r_t}+\frac{1+\gamma_N}{r_N-\gamma_N}\cdot\prod_{t=1}^{N-1}\frac{1+\gamma_t}{1+r_t}}-nc_0+ +\left(-\frac{\sum_{i=1}^{N-1}\left(\Delta nc_i^{*}\cdot\prod_{t=1}^{i}\frac{1+\gamma_t}{1+r_t}\right)}{\sum_{i=1}^{N-1}\prod_{t=1}^{i}\frac{1+\gamma_t}{1+r_t}+\frac{1+\gamma_N}{r_N-\gamma_N}\cdot\prod_{t=1}^{N-1}\frac{1+\gamma_t}{1+r_t}}\right)+ +\left(-\frac{\Delta nc_N^{*}\cdot\frac{1+\gamma_N}{r_N-\gamma_N}\cdot\prod_{t=1}^{N-1}\frac{1+\gamma_t}{1+r_t}}{\sum_{i=1}^{N-1}\prod_{t=1}^{i}\frac{1+\gamma_t}{1+r_t}+\frac{1+\gamma_N}{r_N-\gamma_N}\cdot\prod_{t=1}^{N-1}\frac{1+\gamma_t}{1+r_t}}\right), \quad (A.8)$$ where N – last year of projection, $r_N>\gamma_N$	$$S2^{a}=\frac{\text{б}_0}{\sum_{i=1}^{N-1}\prod_{t=1}^{i}\frac{1+\gamma_t}{1+r_t}+\frac{1+\gamma_N}{r_N-\gamma_N}\cdot\prod_{t=1}^{N-1}\frac{1+\gamma_t}{1+r_t}}-\tilde{nc}_0+ +\left(-\frac{\sum_{i=1}^{N-1}\left(\Delta\tilde{nc}_i^{*}\cdot\prod_{t=1}^{i}\frac{1+\gamma_t}{1+r_t}\right)}{\sum_{i=1}^{N-1}\prod_{t=1}^{i}\frac{1+\gamma_t}{1+r_t}+\frac{1+\gamma_N}{r_N-\gamma_N}\cdot\prod_{t=1}^{N-1}\frac{1+\gamma_t}{1+r_t}}\right)+ +\left(-\frac{\Delta\tilde{nc}_N^{*}\cdot\frac{1+\gamma_N}{r_N-\gamma_N}\cdot\prod_{t=1}^{N-1}\frac{1+\gamma_t}{1+r_t}}{\sum_{i=1}^{N-1}\prod_{t=1}^{i}\frac{1+\gamma_t}{1+r_t}+\frac{1+\gamma_N}{r_N-\gamma_N}\cdot\prod_{t=1}^{N-1}\frac{1+\gamma_t}{1+r_t}}\right), \quad (A.16)$$ where N – last year of projection, $r_N>\gamma_N$, $\tilde{nc}_0=nc_0+np_0+ao_0-\delta_0$, $\Delta\tilde{nc}_i^{*}=\Delta nc_i^{*}+\Delta np_i^{*}+\Delta ao_i^{*}-\Delta\delta_i^{*}$, $\Delta\tilde{nc}_N^{*}=\Delta nc_N^{*}+\Delta np_N^{*}+\Delta ao_N^{*}-\Delta\delta_N^{*}$	$$S2^{ав}=\frac{\text{б}_0}{\sum_{i=1}^{N-1}\prod_{t=1}^{i}\frac{1+\gamma_t}{1+\tilde{r}_t}+\frac{1+\gamma_N}{\tilde{r}_N-\gamma_N}\cdot\prod_{t=1}^{N-1}\frac{1+\gamma_t}{1+\tilde{r}_t}}-\tilde{nc}_0+ +\left(-\frac{\sum_{i=1}^{N-1}\left(\Delta\tilde{nc}_i^{*}\cdot\prod_{t=1}^{i}\frac{1+\gamma_t}{1+\tilde{r}_t}\right)}{\sum_{i=1}^{N-1}\prod_{t=1}^{i}\frac{1+\gamma_t}{1+\tilde{r}_t}+\frac{1+\gamma_N}{\tilde{r}_N-\gamma_N}\cdot\prod_{t=1}^{N-1}\frac{1+\gamma_t}{1+\tilde{r}_t}}\right)+ +\left(-\frac{\Delta\tilde{nc}_N^{*}\cdot\frac{1+\gamma_N}{\tilde{r}_N-\gamma_N}\cdot\prod_{t=1}^{N-1}\frac{1+\gamma_t}{1+\tilde{r}_t}}{\sum_{i=1}^{N-1}\prod_{t=1}^{i}\frac{1+\gamma_t}{1+\tilde{r}_t}+\frac{1+\gamma_N}{\tilde{r}_N-\gamma_N}\cdot\prod_{t=1}^{N-1}\frac{1+\gamma_t}{1+\tilde{r}_t}}\right), \quad (A.24)$$ where N – last year of projection, $\tilde{r}_N>\gamma_N$, $\tilde{nc}_0=nc_0+np_0+ao_0-\delta_0$, $\Delta\tilde{nc}_i^{*}=\Delta nc_i^{*}+\Delta np_i^{*}+\Delta ao_i^{*}-\Delta\delta_i^{*}$, $\Delta\tilde{nc}_N^{*}=\Delta nc_N^{*}+\Delta np_N^{*}+\Delta ao_N^{*}-\Delta\delta_N^{*}$, $\tilde{r}_t=r_t^{ін}+\alpha_{t-1}^{н}\cdot\left(r_t^{н}-r_t^{ін}\right)$, $\tilde{r}_N=r_N^{ін}+\alpha_{N-1}^{н}\cdot\left(r_N^{н}-r_N^{ін}\right)$

Source: compiled by the author.

Annex B

MACROECONOMIC AND FISCAL VARIABLES FOR 2005-2018

Table B.1

Macroeconomic variables and variables of the Ukraine's State Budget for 2005–2018

Year, (t)	**Nominal GDP,** *UAH bn*	**Nominal GDP growth rate,** *%,* (γ_t)	**State debt at the end year, in hrivnia equivalent**						**The State Budget expenditures on the state debt servicing, in hrivnia equivalent**						**Effective nominal interest rate on the state debt,** *%*		
			total		including by currencies				total		including by currencies				total, (r_t)	including by currencies	
					in national currency		in foreign currency				in national currency		in foreign currency			in national currency, ($r_t^{н}$)	in foreign currency, ($r_t^{ін}$)
			UAH bn, ($Б_t$)	*% of GDP,* ($б_t$)	*UAH bn,* ($БО_t^{н}$)	*% of GDP,* ($б_t^{н}$)	*UAH bn,* ($БО_t^{ін}$)	*% of GDP,* ($б_t^{ін}$)	*UAH bn*	*% of GDP*	*UAH bn*	*% of GDP*	*UAH bn*	*% of GDP*			
1	2	3 (=(2–2(-1))/2(-1)·k)	4	5 (=4/2·k) (=7+9)	6 (=4–8)	7 (=6/2·k)	8	9 (=8/2·k)	10	11 (=10/2·k) (=13+15)	12 (=10–14)	13 (=12/2·k)	14	15 (=14/2·k)	16 (=10/4(-1)·k)	17 (=12/6(-1)·k)	18 (=14/8(-1)·k)
2005	457	27,9	63	13,8	19	4,2	44	9,6	3	0,7	1	0,2	2	0,5	4,6	4,6	4,6
2006	565	23,5	66	11,7	17	2,9	50	8,8	3	0,6	1	0,2	2	0,4	4,9	4,7	5,0
2007	751	32,9	71	9,5	18	2,4	53	7,1	3	0,4	1	0,1	3	0,3	5,1	4,5	5,3
2008	991	31,9	131	13,2	45	4,5	86	8,7	4	0,4	1	0,1	3	0,3	5,3	4,8	5,5
2009	947	–4,4	227	24,0	91	9,6	136	14,4	9	1,0	5	0,5	4	0,5	6,9	10,4	5,1
2010	1121	18,3	323	28,9	142	12,6	182	16,2	16	1,4	11	1,0	5	0,4	6,8	12,0	3,4
2011	1349	20,4	357	26,5	158	11,7	199	14,8	23	1,7	16	1,1	8	0,6	7,2	10,9	4,2
2012	1459	8,1	399	27,4	166	11,4	233	16,0	24	1,7	16	1,1	8	0,6	6,8	10,1	4,1
2013	1523	4,4	480	31,5	206	13,5	274	18,0	32	2,1	19	1,2	13	0,9	7,9	11,2	5,6
2014	1587	4,2	947	59,7	381	24,0	566	35,7	48	3,0	27	1,7	21	1,3	10,0	13,1	7,7
2015	1989	25,3	1334	67,1	432	21,7	902	45,4	85	4,2	51	2,6	33	1,7	8,9	13,4	5,9
2016	2385	20,0	1651	69,2	548	23,0	1103	46,2	96	4,0	56	2,3	40	1,7	7,2	12,9	4,4
2017	2984	25,1	1834	61,5	631	21,1	1203	40,3	110	3,7	64	2,2	46	1,5	6,7	11,7	4,2
2018	3561	19,3	1860	52,2	623	17,5	1237	34,7	115	3,2	67	1,9	49	1,4	6,3	10,6	4,0

Continued table B.1

Year, (t)	Annual change in state debt, *UAH bn*	Share of state debt denominated in national currency, %, ($\alpha_t^н$)	Amount of State budget financing, in hrivnia equivalent								Deviation of change in state debt from amount of financing by debt operation		Balance of State Budget		Primary balance of State Budget		Adjusted primary balance of State Budget	
			total		including by sources for financing													
					by debt operation		from state property privatization		from active transactions									
			UAH bn	*% of GDP*	*UAH bn*, ($БО_t$)	*% of GDP*, ($бо_t$)	*UAH bn*, ($Пр_t$)	*% of GDP*, ($пр_t$)	*UAH bn*, (AO_t)	*% of GDP*, (ao_t)	*UAH bn*, (Δ_t)	*% of GDP*, (δ_t)	*UAH bn*	*% of GDP*	*UAH bn*, ($ПС_t$)	*% of GDP*, ($пс_t$)	*UAH bn*	*% of GDP*
1	19 (=4–4(-1))	20 (=6/4·k)	21 (=23+25+27) (=–31)	22 (=23/2·k) (=24+26+ +28)	23	24 (=23/2·k)	25	26 (=25/2·k)	27	28 (=27/2·k)	29 (=19–23)	30 (=29/2·k)	31 (=–21)	32 (=31/2·k)	33 (=10+31)	34 (=33/2·k) (=11+32)	35 (=25+27– –29+33)	36 (=35/2·k) (=26+28- 30+34)
2005	–5	30,4	7,7	1,7	–0,5	–0,1	20,8	4,5	–12,5	–2,7	–4,0	–0,9	–7,9	–1,7	–4,8	–1,1	7,4	1,6
2006	3	25,1	3,8	0,7	2,0	0,4	0,6	0,1	1,2	0,2	1,0	0,2	–3,8	–0,7	–0,7	–0,1	0,1	0,0
2007	5	25,0	9,8	1,3	4,0	0,5	2,5	0,3	3,4	0,4	1,2	0,2	–9,8	–1,3	–6,5	–0,9	–1,8	–0,2
2008	59	34,2	12,5	1,3	27,3	2,8	0,5	0,0	–15,3	–1,5	32,1	3,2	–12,5	–1,3	–8,7	–0,9	–55,6	–5,6
2009	96	40,1	35,5	3,8	89,7	9,5	0,8	0,1	–54,9	–5,8	6,6	0,7	–35,5	–3,8	–26,5	–2,8	–87,3	–9,2
2010	96	43,8	64,3	5,7	97,6	8,7	1,1	0,1	–34,4	–3,1	–1,1	–0,1	–64,3	–5,7	–48,7	–4,3	–80,9	–7,2
2011	34	44,3	23,6	1,7	35,0	2,6	11,5	0,9	–22,9	–1,7	–1,2	–0,1	–23,6	–1,7	–0,4	0,0	–10,7	–0,8
2012	42	41,6	53,4	3,7	41,7	2,9	6,8	0,5	5,0	0,3	0,2	0,0	–53,4	–3,7	–29,2	–2,0	–17,7	–1,2
2013	81	42,9	64,7	4,2	81,0	5,3	1,5	0,1	–17,8	–1,2	0,0	0,0	–64,7	–4,2	–33,0	–2,2	–49,3	–3,2
2014	467	40,2	78,1	4,9	201,8	12,7	0,5	0,0	–124,2	–7,8	265,0	16,7	–78,1	–4,9	–30,1	–1,9	–418,8	–26,4
2015	387	32,4	45,2	2,3	117,5	5,9	0,2	0,0	–72,5	–3,6	269,3	13,5	–45,2	–2,3	39,3	2,0	–302,3	–15,2
2016	317	33,2	70,3	2,9	177,3	7,4	0,2	0,0	–107,2	–4,5	139,7	5,9	–70,3	–2,9	25,5	1,1	–221,2	–9,3
2017	183	34,4	47,9	1,6	120,4	4,0	3,4	0,1	–75,9	–2,5	62,4	2,1	–47,9	–1,6	62,6	2,1	–72,4	–2,4
2018	27	33,5	59,3	1,7	52,1	1,5	0,3	0,0	6,9	0,2	–25,5	–0,7	–59,3	–1,7	56,2	1,6	88,8	2,5

Notes:

1. <Column number>(-1) – data from this column for previous year.
2. k=100%.
3. Column 2 – data of the State Statistics Service of Ukraine [22].
4. Column 4 – data of the Ministry of Finance of Ukraine [23].

5. Column 8 is calculated according to data of the Ministry of Finance of Ukraine as *state external debt of Ukraine* [23] ‘plus’ *indebtedness on domestic government bonds denominated in US dollar and euro*, ‘plus’ *indebtedness on treasury bonds in 2012–2014 denominated in US dollar*. *Indebtedness on domestic government bonds denominated in US dollar and euro*: before 2017 – is calculated according to results of domestic government bond placements [24] as the sum of domestic government bonds denominated in US dollars and euros that are not repaid at the end of year; since 2017 – data of the National Bank of Ukraine [25]. I*ndebtedness on treasury bonds in 2012–2014 denominated in US dollar* is calculated according to data of the Ministry of Finance of Ukraine [23] and information of the National Bank of Ukraine [26–28].

6. Column 10 – data of the State Treasury Service of Ukraine: ‘Section II.2. Expenditures by functional classification of expenditures and lending of budget’ of the annual report on the execution of the Ukraine’s State Budget [21].

7. Column 14 is calculated according to data of the State Treasury Service of Ukraine as *expenditures of the State Budget of Ukraine on the servicing of state external debt* ‘plus’ *expenditures of the State Budget of Ukraine on the servicing of domestic government bonds denominated in US dollar and euro*, ‘plus’ *expenditures of the State Budget of Ukraine on the servicing of treasury bonds in 2012–2014 denominated in US dollar*. *Expenditures of the State Budget of Ukraine on the servicing of state external debt* are: before 2012 – respective data of the annual report on the execution the Ukraine’s State Budget under ‘Section II.2. Expenditures by functional classification of expenditures and lending of budget’ [21]; 2012 – respective data according to [29]; since 2013 – respective data of the annual report on the execution of the Ukraine’s State Budget under ‘Section II.3. Expenditures by economic classification of expenditures of budget’ by the general fund of the State Budget of Ukraine [21]. *Expenditures of the State Budget of Ukraine on the servicing of domestic government bonds denominated in US dollar and euro* are calculated according to results of domestic government bond placements [24] as the sum of interest payments on domestic government bonds denominated in US dollars and euro during the year. *Expenditures of the State Budget of Ukraine on the servicing of treasury bonds in 2012–2014 denominated in US dollar* are calculated according to the National Bank of Ukraine [26–28] as the sum of interest payments on treasury bonds denominated in US dollars during the year.

8. Columns 23, 25, 27 – data of the State Treasury Service of Ukraine: ‘Section IV.2. Financing by classification of budget financing by type of debt liability’ of the annual report on the execution of the Ukraine’s State Budget[21].

Source: data of the State Statistics Service of Ukraine, the Ministry of Finance of Ukraine, the State Treasury Service of Ukraine and author's calculations.