

DEBT RESILIENCE DYNAMICS: EXPLORING VULNERABILITY OF MACROSYSTEM

The article on the contemporary approach analysis of sovereign debt reveals the basic structures of national economy alternative financing. The methodology of system dynamics is applied to explain the sovereign debt burden pressure feedback process. The main effects of resilience to external shocks are explored. The problem of dynamic balancing between long-term economic development and short-term financial stability is detected. The analysis for borrowing capacity of the national economy is explored using the system dynamics methods. The resource curse “vicious cycle” should be overridden by increasing total factor productivity and decreasing sovereign debt. The main findings of the article concern the nonlinear relationships in the national economic debt system and reveal the issues of the sovereign debt trap enhanced by the resource type of economic development. The model developed in this article reflects the main role of innovations (total factor productivity growth) in coming out of the “resource curse” debt trap. The hypothesis that sovereign debt can be eliminated arises from the possibility of autonomous national economic development and endogenous business cycle stabilization. Such a point of view allows to capture the important interrelationships between the national economic development and external borrowings due to the concept of policy resistance implementation. It is indicated that the complex systems modeling likelihood to develop the sovereign debt policy for demonstration of the negative impact of debt trap on economic development. In order to achieve the results, issued in the article, a basic control loop model was developed using reference mode data with appropriate initial structure model construction.

Keywords: system dynamics, sovereign debt, debt resilience, resource curse, debt trap.

JEL classification: B22, C53, C61, E17, E5

Introduction and research problem. Sovereign debt is a result of national financial system underperformance, which is influenced by the disequilibrium in economic, social and technological sectors and many of the side effects (Sterman, 2000, p. 7). The problem of acceleration of the sovereign debt complex determines the importance of providing the holistic approach to the appropriate policy application. Sovereign debt can be also represented as a system which shows the appropriate relationships between national savings and investment resources on the one hand and the debt and GDP on the other hand. For market access countries, a debt is considered sustainable as long as the debtor is able to continue servicing the debt without an unrealistically large future correction in the balance of income and expenditure.

The problem description and its relevance: our model is designed to explain how to minimize the negative effects of external borrowing on the national economy and to go out of the resource curse. We focus on managing the sovereign debt burden – balancing the interests of internal short-run and long-run economic development with the necessity to pay off the external debt as well. The

core question of our problem is “How not to get into a trap of the indebtedness “vicious circle” (the cause of the problem) and simultaneously sustain the high consumption level?”

The core issue that the national economies are often most concerned with is connected with understanding: “Why the sovereign debt has emerged in general and why the implemented policy to it has failed?” In particular, has a “vicious circle” indebtedness of Ukrainian economy achieved the critical threshold to critically affect the economic growth? The positive answer generates another question: “What are the internal economic resilience forces to suppress the negative effect of over-indebtedness?” “Maintaining macro-financial stability in the country requires extraordinary efforts and extraordinary decisions from the state in order to activate the levers of growth of the national economy and to effectively manage Ukraine’s public debt” (Bohdan, 2018, p. 26).

All above mentioned indicates the urgency of solving the debt problem in Ukraine, which is the developing country. This research concentrates on the problem of the resource curse in the developing world (case of Ukraine) created by its resource

wealth. The outflow of natural resources is not compensated by debt inflow, thus the national investment stock decreases. The capacity resilience of the resource – oriented economies is not enough to resist the external debt vulnerability. In this case the new problem may arise: “What are the main steps to come from the above – mentioned vicious circle and is a panacea to come out from the default risk exists?” Should Ukrainian government be able to change its national debt mental model and use appropriate policy instruments, because for today “the policies we implement are not appropriate and make the problem worse and create a new problem” (Sterman, 2000, p. 6). Ukraine in general is in a transition from one economic model development to another, trying to overcome the national model system crisis. In other case “Significant expenditures of the budget for debt servicing [would] narrow the state’s potential to finance the socio-economic needs of the country” (Bohdan, 2018, p. 8) which in many cases leads to a decrease in the quality of social capital, a decline in the standard of living and a slowdown in economic activity. The mid-term strategy of national debt for 2019–2022 in Ukraine is needed to be overestimated in the context of holistic approach and using system dynamics for rapid overcoming of sovereign debt overhanging and minimizing.

Recent publications analysis. The “pure” sovereign debt theory, as a scientific phenomenon, without its application to the approach of System Dynamics have their modern origins in the work of (Eaton & Gersovitz, 1981, p. 289) in its application to debt with potential repudiation.

This research is dedicated to developing the *learning* system dynamics tool contrary to the *research* tool and specific learning objectives for obtaining a scrutinized feedback result. A set of feedback loops that can *restore or rebuild feedback loops* is the resilience at a still higher level. Even higher meta-meta-resilience comes from feedback loops that can *learn, create, design, and evolve* even more complex restorative structures (Meadows, 2008, p. 76).

The proposed scientific paper concept based on debt resilience as *economic methodology* is based on the principle of identifying the debt-to-income ratio. Despite the fact that many national economies have already obtained an experience in overcoming the cyclical resource crisis and have become resilient to external shocks, the problem still exists (Primo Braga & Vincelette, 2011, p. 2), because the debt resilience is a result of the time gap or “delays arise because both the debtor and the creditors prefer to wait for a good future shock to split a large ‘pie’”

(Bai & Zhang, 2012, p. 3). We also need to take into account the fact of “sovereign risk influence on banking feedback risk” (Erce, 2015, p. 1).

Unsolved parts of the problem. The above-mentioned past experience of the debt resilience determination does not reflect the interrelationships and holistic approach to the problem. Despite some recent efforts to assess the implications of resource to the concept of resilience for planning theory, the field is still largely open for further inquiry.

From a long-term perspective, many developing countries are more resilient than ever. The emphasis of our research is not on a pure sovereign debt, as it is, but on mid-term and long-term oscillations of the sovereign debt cycle, which lead either to resilience of the national economic system to external financial shocks or degradation and collapse, without any economic recovery. Unresilience is the core problematic behaviour which can arise. On the other hand, the lack of resilience is an “outward behaviour of often complex systems” (Meadows, 2008, p. 12).

To summarize all the above mentioned, the phenomenon of the debt resilience model in this article is intended to elucidate the causes of national debt as a systemic problem. The author’s opinion is that the debt ruins the natural mechanism of economic macroeconomic regulation, but the elements of vulnerability and resilience inherited in any of this kind of the national system make the feedback response of the system to external shocks. Our view on the debt resilience is ambivalent. The debt resilience is the ability of the system to overcome the internal transformation difficulties connected with debt servicing and paying-off the debt. On the other hand, the debt resilience is similar to the addicted-behavior archetype system trap. From this point of view, the debt resilience is the unwillingness of the national economic system to live without a new portion of debt. The unfavorable outcomes of the debt crisis could be overcome by special policy measures implemented in the national macroeconomic program of the state debt regulation. A special set of tools should be developed to solve the problem of recovering and turning back to a steady level of economic growth.

Research goal and questions. Basic hypothesis: Vulnerability (resource curse) of the national macroeconomic resource – based system is reinforced by a new credit cycle, caused by the resource boom. The resilience of the system to external loan pay-off and new borrowing is constantly decreasing due to the fact of the “boom-based borrowing capacity.” System dynamics methods allow us to develop a set of conceptual and operational tools using computer simulations and to

give recommendations about avoiding the resource debt trap in the future for Ukrainian economy after exploring its internal debt structure and debt policy. The debt resilience can take the form of a preventing mechanism on the state level to avoid the possible scenario of destructive effects of debt overhanging.

Resilience practical application and the relevance of the problem to the field of sovereign debt using system dynamics. The term ‘debt resilience’ does not have a unified meaning in different sources. Debt resilience is an exposure of the national economy to external financial shocks and reflects the level of safety, intrinsic in itself. The failure to reach safety is due to lack of the integral function of resilience and the ability to control the macrosystem or macroeconomic policy incompetence. Inside the boundary of resilience, the mental model is also the endogenous parameter of risk assessment and its avoidance. Sovereign debt safety is one of the core principles of the national credit system operational management. “A system is safe if it is impervious and resilient to perturbations and the identification and assessment of possible risks is therefore an essential prerequisite for system safety” (Hollnagel, Woods & Leveson, 2006, p. 9). System safety, according to J. Reason Swiss cheese model of *accident* causation, accumulates failure and finally can lead to a break down of the system. There was unsystematic accumulation of external sovereign credits in Ukraine (the model *ancestry*) at the beginning of the 1990s, causing the debt dependence. The ancestry caused the actors, or persons (in the national credit policy) to behave improperly. This caused financial hazards to appear which led to financial problems (*accident*) and finally to injury in the economic system and serious long-term economic disproportions. The “holes” in the national credit system are caused exogenously by international financial capital flows (the external variability of the environment), in which the financial systems of separate countries are embedded and endogenous imperfect financial structure (variability of the constituent subsystems (Hollnagel, Woods & Leveson, 2006, p. 12)). The *accident* has a non-linear nature (concurrence) and needs special research.

Main findings. The systemic view basics on sovereign debt are the following:

- The adjustment period is needed to adapt the national financial system to external shocks (normal versus normative performance);
- Local optimization (sovereign debt adjustment process) leads to GDP growth.

Taking into account the methodology of (Hollnagel, Woods & Leveson, 2006, p. 23), we need to create the essential properties of the financial

system resilience to external shocks in the form of sovereign debt:

- buffering capacity – financial disruptions of sovereign debt, which cannot be able to ruin the national financial system (sovereign default occurrence) and the level of this disruptions, which this system is able to absorb;
- flexibility versus stiffness – the ability of a financial system to be restructured under the sovereign debt pressure;
- margin – how close the financial system is to the external boundary of the sovereign default;
- tolerance – what is the internal potential of the financial system to resist the possible sovereign default occurrence (does the system disintegrate under external pressure circumstances?)

Downward resilience may occur in a case of the debt mismanagement. The characteristics of effective public debt management may be the following (Hollnagel, Woods & Leveson, 2006, p. 23):

- Co-ordination with monetary and fiscal policies;
- Availability of information;
- Public debt management strategy;
- Risk management framework;

Upward resilience is affected by how adaptations by local actors in the form of workarounds or innovative tactics reverberate and influence more strategic goals and interactions (Hollnagel, Woods & Leveson, 2006, p. 23); for instance, in Ukraine it would be appropriate to combine all controls of public debt in one institution. An extremely negative element of the system of public debt management in Ukraine is the distribution of powers between several state institutions (Slaviuk, 2019, p. 116). The important problem of dynamic balancing is the policy conflict, for instance between long-term economic development and short-term financial stability. Increasing external debt eliminates the possibility to invest intensively in innovations and creates the debt “vicious circle”.

Time definition. Time horizon of reference mode is 1991–2019. The methodology of system dynamics states not to predict the future, but to explain the fundamental causal relationship of the problem: “Why has it happened? Why do we have the structure of the debt in the resource-based economy nowadays?”

Reference mode development. We choose GDP, sovereign external debt and rent in absolute values to build the graph, which reflects the relationship between the rent-existing behaviour and the national welfare.

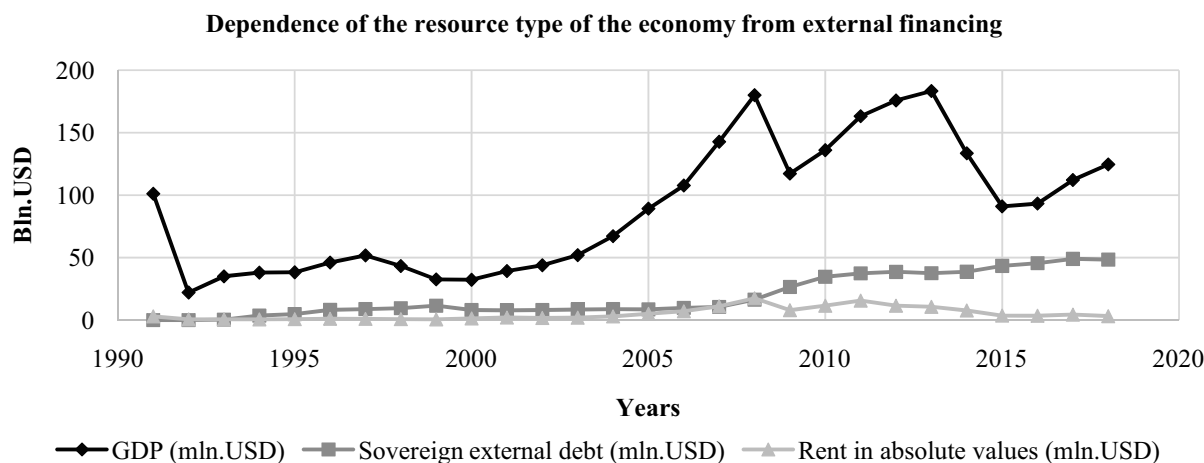


Fig. 1. Sovereign debt of Ukraine in comparison with GDP and natural rent (bln. USD)
 Source: drafted by the author on the basis of (State Statistics Service of Ukraine, 2020)

As we see from Figure 1, the absolute growth of sovereign debt in Ukraine has no signs of sharp oscillations to compare with GDP, especially after the 2008 global crisis. It means that the “GDP module” is struggling for survival and affected by time and information delays. The structure of sovereign debt at the first glance reminds S-shaped growth with the limited by the interest rate and factors of production quantitative and qualitative capacity to increase the sovereign debt stock. Since 2008 the sovereign debt level has been increasing dramatically. As a result, the expenses of debt servicing have strongly increased as well as threaten the national economic security due to the debt secure threshold overcoming. At the same time, since 2008 the widening gap between the rent in absolute values and the sovereign debt exists. It means that the real value of national resources constantly and increasingly lags behind the external debt, which increases the vulnerability of the national economy to the vicious growth cycle reflects the trend of sovereign external debt to growth simultaneously with rent and GDP falling and reflects the change in the Total Factor Productivity (TFP). TFP dynamics in Ukraine, calculated by the Solow model, is characterized by high growth rates by 2012, a sharp fall in 2013–2015, and a return to the growth path in 2016–2017, but, as in the whole world, by a very moderate pace (Kvasha, 2019, p. 15). “We have to decrease the negative impact of sovereign debt on the

growth of productivity” (Pattillo, Poirson & Ricci, 2004, p. 1). We associate TFP with Solow residual and measure it in USD/year.

The purpose of our model is to evaluate the influence of the debt backlog on national welfare, that’s why the political instability, domestic conflict as well as derivative financial instruments and financial legislation, which have indirect impact on economic development are not included in our model. External lending is also excluded from the analysis, because Ukraine is a net-debtor in the world for this moment.

Initial structures. The starting point for our model structuring is a *casual* look at the data, which must confirm the strong connection that exists between international lending and commodity prices: international financial markets lend money during commodity booms and restrict liquidity during busts which leads to resource-oriented trap for the national economy.

The following step provides the analysis of writing the “system dynamics compound sentence” with “at least two stocks linked by at least one flow” (Slaviuk, 2019, p. 45).

The annual borrowing pay-off (the debt pay-off period) for external debt must be exogenous – it is predetermined by international borrowing rate and supply and demand on the international credit market. When the sovereign government decided to

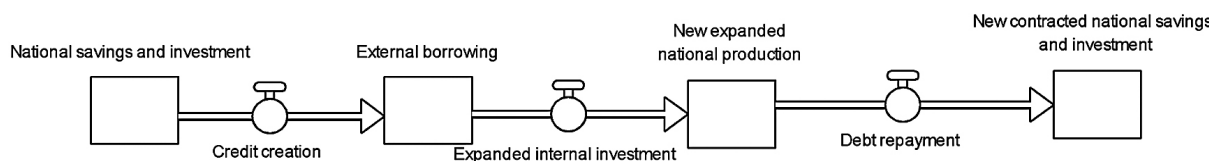


Fig. 2. Preliminary main chain of the relationship between national savings – investment and external debt

borrow on the international market, the interest rate for debt was established. There is the possibility to reschedule or write off the debt, but the precedent has been already made. The external debt is increased by interest debt loans and decreased by paying off the principal.

Debt burden reflects the time and economic alternatives needed to pay off the external debt. The developing countries need adjustment time to adapt their economies to new conditions for simultaneously paying-off large share of their income as the debt with sustaining the economic development. The accelerating technological progress increases the chance to pay off the debt. The second strategy is to increase the share of existing national income to pay off (to sacrifice the current consumption in favour of debt pay-off).

The following diagram for the debt pay-off period reflects the basic control loops for sovereign debt.

There are 4 feedback loops (3 Reinforcing and 1 Balancing) on the figure, presented above. The ideal model of debt paying-off does not show us the possible debt rescheduling and possible debt paying off (side effects). Debt rescheduling is the cause of possible debt pay – off delay with the appropriate interest rate increasing. As the future debt burden level increases, the sacrifice level (alternative economic costs) increases. The burden pressure on the society increases. Low growth of productivity provokes the budget deficit to grow and credit interest rates by credits to grow.

Recessionary gap is a result of reducing global demand for commodities, and therefore – export

price for commodities. The result is lower cost-push inflation and greater recessionary gap. The main problem is long term external debt, which leads to further economic development deceleration.

Conclusions and further research proposals.

The research, which was carried out, demonstrated the main features of Ukrainian external debt market and showed the dangerous period of inevitable debt trap. The carried-out analysis reflects the situation, which in general is similar to the reference mode, constructed above: the borrowing capacity of Ukraine was high at the first 6 years of independence (the period from 1991 to 1997), due to the absence of debt overhang. The period from 1997 to 2008 was characterized by an economic recovery and resource-oriented boom, which ended up in 2008 as a result of the Global Financial Crisis. The above-mentioned boom actually maintained the borrowing capacity, which marginally already started to decline. *Span of the debt control* for the national economy now is the ability of the macroeconomic system to overcome (to resist) economic depression, political and economic transformations and to survive without not losing control on its economic and geographic territory, being in a state of dynamic equilibrium.

What is the way out? To overcome staying in the vicious circle, it is important to have the impetus for economic development for shifting to a new technological stage. Selling farmland (with severe restrictions) is among other things budgets income, which under correct government economic policy may lead to technological renovation.

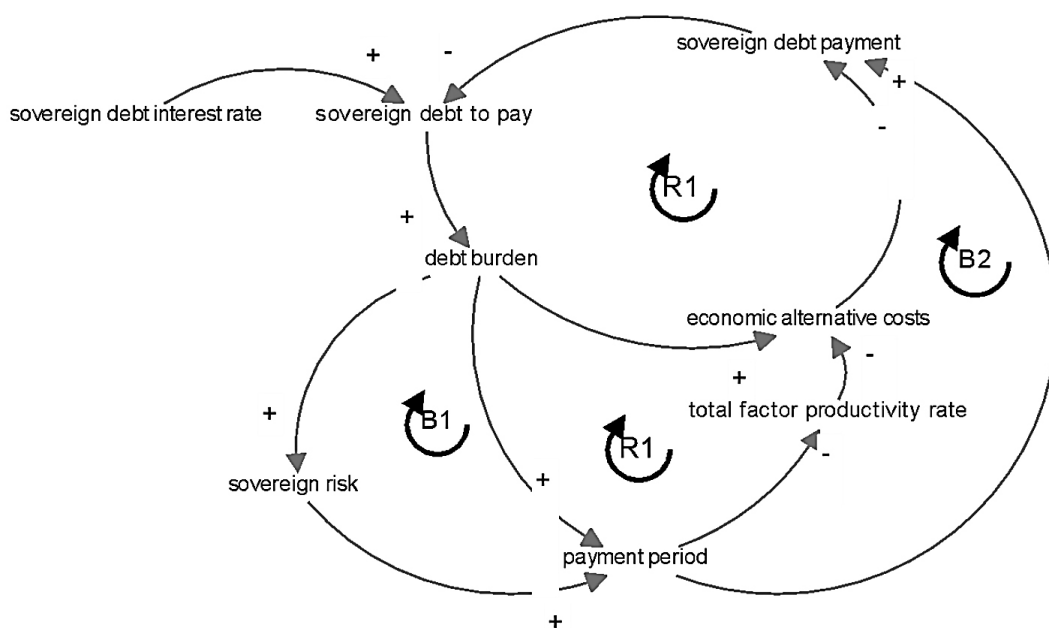


Fig. 3. Basic control loops for sovereign debt

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ДИНАМІКА БОРГОВОЇ СТІЙКОСТІ: ДОСЛІДЖЕННЯ ВРАЗЛИВОСТІ МАКРОСИСТЕМИ

Статтю присвячено дослідженню сучасних підходів до аналізу суверенного боргу та виявленню базових структур альтернативного фінансування національної економіки. Метою дослідження є встановлення головних ефектів уразливості національної економіки до зовнішніх шоків. Виявлено системну проблему динамічного балансування між довгостроковим економічним розвитком та фінансовою стабільністю. Проведено аналіз чутливості боргового потенціалу за допомогою методів системної динаміки. Доведено, що «зачароване коло» ресурсного прокляття може бути подолане за допомогою зростання сукупної продуктивності факторів виробництва та зменшення суверенного боргу.

Для подолання перебування в порочному колі важливо мати поштовх для економічного розвитку та переходу на новий технологічний етап економічного розвитку. Результатами дослідження стало наукове доведення того факту, що борговий потенціал України був суттєво занижений через відсутність виходу за межі ресурсного циклу розвитку. Період економічного відновлення кінця 90-х років ХХ століття в Україні, який, як відомо, завершився залученням національної економіки в процеси глобальної економічної кризи, зменшив у рази борговий потенціал. Основна ідея цієї статті полягає в розробленні діапазону боргового контролю для національної економіки, який дає змогу вчасно виявляти критичну межу боргового навантаження суверенних ризиків.

Можливе застосування результатів дослідження полягає в наданні рекомендацій фінансово-економічним інституціям щодо зменшення ризиків боргового нависання на макrorівні як методики подолання (протидії) наслідків економічної кризи та перебування в стані динамічної рівноваги.

Висновки статті, підтвержені проведеним дослідженням, вказують на нетривкий період експансії національного виробництва, базованої на фінансуванні за допомогою лише фінансових інструментів. Скорочення національного ВВП після сплати боргів залежить від потенціалу нового рівня виробництва для покриття основної суми боргу та відсотка.

Ключові слова: системна динаміка, суверенний борг, боргова стійкість, боргова пастка, ресурсне прокляття.

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