A CYBERNETICS APPROACH
TO THE SOVEREIGN DEBT CRISIS

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The purpose of this paper is to approach the sovereign debt crisis from a cybernetics
perspective, as a system that includes several interrelated subsystems. We emphasize the
dynamic nature and sustainability of the sovereign debt system. The paper also discusses the
transition from a sovereign debt dynamic system to a sovereign debt crisis dynamic system,
transition included in the feedback control loop of the dynamic system of national economy.

**Key words:** sovereign debt crisis, cybernetics approach, dynamic system, national
economy, feedback.

**JEL Classification:** C22, H63, P4.

1. INTRODUCTION

The systemic approach to the national economy through the dynamics, feedback and self-regulation
of internal mechanisms is determined by the multidimensional complexity of the micro, meso and macroeconomic
systems, which are adjusted through macroeconomic policies.

Starting from the widening strategy of covering budget expenditures by making loans, sovereign debt is one of
the tools which irreversibly influence the internal and external behavioral trajectories of the economic system, thus
causing the economic system’s response to internal and external changes.

The cybernetics of sovereign debt crisis requires a comprehensive approach, which should be framed into
the macroeconomic system. The system corresponding to sovereign debt is composed of complex elements. These
elements are interdependent (e.g. debtor-creditor relations, the amount borrowed, contractual terms, balance
of payments etc.) and work together to achieve the desired objective (namely, covering the budget deficit).

2. THE DYNAMIC SYSTEM OF NATIONAL ECONOMY

The National Economy System (NES) is defined by the characteristics of a Complex Adaptive System (CAS). The
study of processes within the national economy system is carried through aggregated indicators that comprise
“flows and levels of connections and interdependencies” between the subsystems of the national economic

3. THE DYNAMIC SYSTEM OF BUDGET DEFICIT FINANCING

Sovereign debt - a regulating instrument in the feedback mechanisms
for financing the budget deficit - requires a brief presentation of the budget deficit, according to [2] Scarlat (2005). The relationship defining the budget deficit is:

\[ \text{Def}_t = \text{Bud}_{\text{rev}}_t - \text{Bud}_{\text{exp}}_t \]  \hspace{1cm} (1)

where:

- \( \text{Def}_t \) - The budget deficit at time \( t \);
- \( \text{Bud}_{\text{rev}}_t \) - Budget revenue at time \( t \);
- \( \text{Bud}_{\text{exp}}_t \) - Budgetary expenditure at time \( t \);

The constituents of the process of budget deficit financing (Figure 1) are:

- \( M \) – money supply;
- \( O_{\text{guv.B.tez}} \) – is the value of government bonds and treasury bills;
- \( C_{\text{acord.s.p}} \) – are the loans to the private sector;
- \( \text{Dob.dat} \) – is the interest paid on public debt;
- \( R_{\text{dob.a}} \) – is the interest rate on government assets level;

Fig. no. 1. The processes of budget deficit financing
Starting from the systemic approach of sovereign debt, it results that the Real Economy Cybernetic Subsystem is influenced through government transfers, taxes and duties. Moreover, a positive budget deficit will induce the rise of public debt, while a negative budget deficit will induce a decrease in public debt.

If the debt can be fully exchanged in coins, the volume of available money supply would exceed the values of CTD (current transactions demand), SMD (speculative money demand) and SD (security demand). At the same time, governmental strategies are oriented to achieving loans - whose aggregate value would amount to the total value of government bonds and treasury bills – relationship included in relationship (VIII). The interest rate for government assets \( R_{dob\_a} \) is what determines the amount of interest paid on debt related \( (Dob\_dat) \), conditioning shown through relationship (V). There also is an inverse relationship between the volume of money supply \( (M) \) and the

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**Fig. no. 2.** The basic feedback loop formed at the level of the budget deficit financing system
value of government bonds and treasury bills \(O_{gov \_B \_tez}\), as emphasized by (XIII). On the other hand, \(O_{gov \_B \_tez}\) influences the value of the interest rate on government assets \(R_{dob \_a}\). The volume of money supply \(M\) is strongly influenced by the level of loans granted to the private sector \(C_{acord \_s \_p}\), as evidenced in relationship (XII). Relationships (X) and (XI) highlight the inverse proportionality between the money supply \(M\) and the interest rate on loans to the private sector \(R_{dob \_c}\) and respectively, the direct proportionality between \(M\) and the level of loans granted to the private sector \(C_{acord \_s \_p}\). An increase in the interest rate on loans to the private sector will lead to a diminishing consumption value. According to relationship (XVII), a significant interest rate on loans to the private sector \(R_{dob \_c}\) will lead to a decrease in the net profit of companies \(P_{n \_f}\).

The Monetary Economy Sistem (MES) affects the path of the Real Economy System (RES). But RES also has a major impact on MES, a phenomenon highlighted by relationships (XIV) and (XV), through government consumption \(Cons_{gouv}\) and prices level \(Pr_{lev}\).

The basic feedback loop formed at the level of the budget deficit financing system is presented in figure 2. Therefore, the feedback loop presents in its structure reverse connections between its constituent elements. A growing trend in the annual budget deficit \(Def\) leads to an increased public debt \(Dat_{pub}\) and also to an increased risk of rising government debt. An increase in the volume of public debt leads to the need for a greater money supply and also to an increased volume of government bonds and treasury bills transactions \(O_{gov \_B \_tez}\), increasing the value of stock assets. Reducing the value of the interest rate on government assets \(R_{dob \_a}\) - which is induced by the increased value of stock-type assets - determines a diminished value of the interest paid on public debt \(Dob_{dat}\). Subsequently, the feedback process reaches the starting point and ends with a diminished budget deficit. A negative status of the feedback loop designates the interrelation between money supply \(M\) and public debt \(Dat_{pub}\), in order to optimize the covering of budget deficit.

### 4. THE DYNAMIC SYSTEM OF SOVEREIGN DEBT AND ITS SUSTAINABILITY

According to Albu [3] (2008), the equation of budget constraints is considered the starting point for studying the dynamics and sustainability of sovereign debt and looks as follows:

\[
\Delta dat = (\rho_t + r_t) dat_{t-1} + def_t + fin_t \tag{2}
\]

where:
\[
\Delta dat = dat_t - dat_{t-1} \quad \text{the difference between government debt at time } t, \text{ Dat}_t, \text{ and government debt at time } t-1, \text{ Dat}_{t-1}.
\]
\[
r_t \quad \text{the average nominal interest rate on public sector debt, at time } t;
\]
\[
\rho_t \quad \text{the coefficient of the revaluation effect of public sector debt at time } t;
\]
\[
def_t \quad \text{the primary deficit at time } t, \text{ expressed as a percentage of GDP;}
\]
\[
fin_t \quad \text{the direct budgetary funding from the Central Bank at time } t.
\]

Optimizing the budget constraint equation implied dividing relationship (2) to the nominal rate of GDP, yielding to:
\[ \Delta \text{dat} = \text{def}_t - \text{fin}_t + \frac{\text{dat}_{t-1}(\rho_t + r_t)}{1 + n_t} \]  

where:

- \( n_t \) – is the nominal growth rate of GDP in period \( t \) to \( t-1 \).

The nominal GDP growth rate will be regarded as the sum between the changes produced in the GDP deflator (\( \text{def} \)) and the real GDP growth rate [4] (Albu, 2008). Equation (3) becomes:

\[ \Delta \text{dat} = \text{def}_t - \text{fin}_t + \frac{\text{dat}_{t-1}(\rho_t - g_t)}{1 + n_t} \]  

where:

- \( g_t \) – the real growth rate of GDP in period \( t \) to \( t-1 \).
- \( w_t \) – the average real effective interest rate on public sector debt.

The iterative resolution of relationship (4) determines the dynamics of debt accumulation. We therefore have:

\[ \text{dat}_t = \text{dat}_{t-1} + \lambda \sum_{j=1}^{T-1} (\text{def}_j - \text{fin}_j) \lambda^{T-j} \]

where:

\[ \lambda = \frac{1 + w + \text{def}l}{1 + \text{def}l + g} \],

\( \text{def}l \) – the GDP deflator.

A positive real growth rate of GDP induces a decreasing debt ratio in GDP. Sustainability requires complying with the system limitations, which implies maintaining its continuous functionality to acceptable levels. Controlling the impact of economic activities upon the micro and macroeconomic policies in order to optimize the structuring and implementation of adequate policies is a good example in this direction.

According to Albu [4] (2008), the function expressing the sustainability of the sovereign debt dynamic system is:

\[ S = (\text{def} - \text{fin})/\text{dat} + (w - g)/(1 + g + \text{def}l) \]  

where: \( \text{def} \) – is the primary deficit as a percentage of GDP;

- \( \text{fin} \) – direct budgetary funding from the Central Bank, relative to GDP;

- \( w \) – is the effective average interest rate on real public sector debt;

- \( g \) – is the real rate of GDP growth in the current time against reference period \( \text{def}l \) – is the GDP deflator; \( \text{dat} \) – is the government debt.

The first order condition of the sustainability function implies that relation (6) will converge to zero in dynamics or towards an infinitesimal constant amount. The switching from dynamic system of sovereign debt to the dynamic system of sovereign debt crisis is comprised in the control of the feedback loop, represented in Figure 2 by the governmental risk of not being able to honor its term obligations towards foreign creditors, banks, etc. When this risk intensifies, the connections at the NES level change and, for a quick adjustment, NES will suffer major shocks, reflected in the harsh austerity policies adopted at the level of banking, government spending etc.

REFERENCES


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