paying taxes to the government, what can lead to increasing of government revenues and GDP.

7. Moreover, implementing policy of tax reducing (both social contribution for employers and income taxes for employees) will decrease the tax burden not only for ordinary workers, but also for enterprises that operate in a shadow. Thus, they will switch to legal work and bring more tax revenues to the state.

8. Improving the law system (because existing one doesn't contain appropriate punishment for people who participate in corruption schemes of lowering real taxable income). If our law enforcement structures (tax police) jail officials who take bribes, level of corruption will decrease immediately.

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PATH DEPENDENCE IN SOVEREIGN DEBT MODELLING

Ukrainian economy is on the path to overcome economic downturn and to reduce substantially the sovereign debt level. Nevertheless, it is still under considerable pressure of sovereign debt fluctuations nowadays. The Ukrainian economy is choosing the way of sovereign debt extension relatively to other types of budget deficit financing, though initially there were a lot of relatively equal different types of financing. It turned up, that the sovereign debt as of September 2020 is getting locked in due to a process of the debt noose. The debt restructuring in 2014

and actual default in Ukraine has decreased the sovereign debt credibility and operating environment of national financial system.

In our research we define the outcome probability of the sovereign debt critical increasing which may lead to sovereign default and depends (or has an impact) on the series of previous events (especially sovereign defaults and debt restructuring). In turn the historical events have the critical importance in a path dependence event. The sovereign debt precedence in a past creates the chain of events (including sovereign debt noose) which influence on a nowadays policy decisions. One of the core tasks of the research is to define the critical policy decisions which have led to a serious debt problem as a current economic outcome. Choice in the past formats the modern mental structure.

This abstract is devoted to the problem of sovereign debt as a continual of logical interconnected steps (path dependence).

In this thesis we present some basic issues concerning sovereign debt path dynamics demonstrating linear and linear process using a continuous function of time. The determination of this function is especially important for intertemporal trade, the decision making concerning external borrowing as well as principal and interest repayment.

Main purpose of research is to implement one of the basic dynamic concepts - time path dependence, into sovereign debt sphere of analysis with the elaborating the appropriate model using the continuous dynamic model. One of the main questions, we are trying to answer is: "Is sovereign debt dynamic equilibrium (in Ukraine) stable, unstable or moving around?"

To formalize the problem to find out the dynamic change of the variable (contrary to static change), we apply the "debt snowball concept" [2] using recursive dynamic approach (with an interpretation of [1]):

$$\frac{D_t}{Y_t} - \frac{D_{t-1}}{Y_{t-1}} = \frac{PD_t}{Y_t} + \left(\frac{D_{t-1}}{Y_{t-1}} * \frac{i_t - y_t}{1 + y_t} \right) + \frac{SF_t}{Y_t} \quad (1)$$

where **D** is the sovereign debt level, **Y** is nominal GDP, **PD** is the primary deficit, **i** is the average (nominal) interest paid on government debt, **y** is the nominal GDP growth rate and **SF** is the stock-flow adjustment.

The balance of forces in the above – mentioned model is a complex number of the interrelation between the group of indicators. The dimensionless number (x*) establishes this balance of forces between the parameters and named *equilibrium constant*. This research is very basic one but may be extended to Poisson distribution for finding the probability of equilibrium existence in a future.

The dynamic recursive models are presented in the research in linear and nonlinear form with the period of 1991 – 2018 for Ukrainian economy, which gives us the multi – order recursive equation.

Linear model. The starting value of the sovereign debt time path is proceeded from the zero level of sovereign debt in 1991 (X (0) = 0). The calculation within the above presented formula (1) has created the linear formula with the appropriate figure of the following type:

| a= | -1.89 | | xstar= | 1.488189 |
| b= | -0.27 | | | |

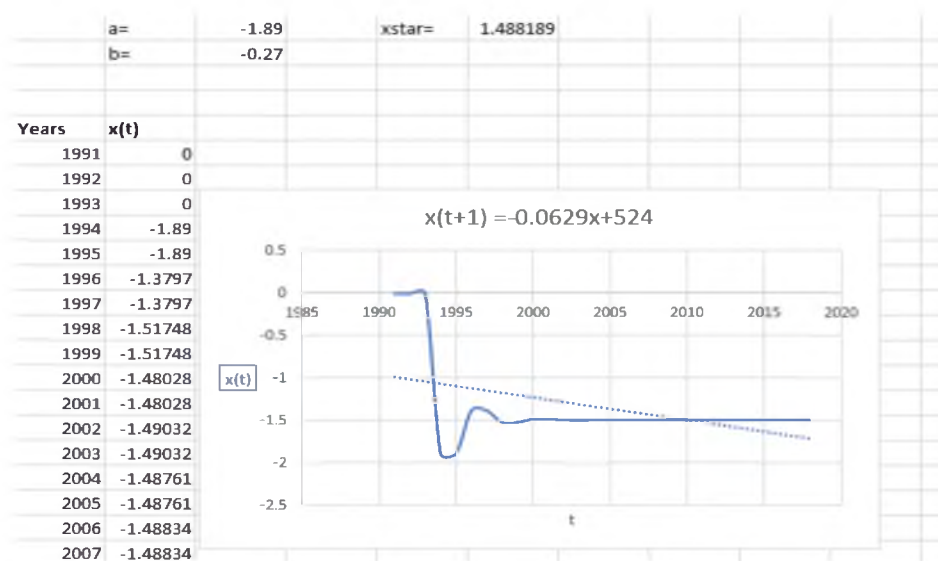| Years	x(t)
1991	0
1992	0
1993	0
1994	-1.89
1995	-1.89
1996	-1.3797
1997	-1.3797
1998	-1.51748
1999	-1.51748
2000	-1.48028
2001	-1.48028
2002	-1.49032
2003	-1.49032
2004	-1.48761
2005	-1.48761
2006	-1.48834
2007	-1.48834

x(t+1) =-0.0629x+524

Figure 1. Finding the fixed point as an equilibrium value for a country's sovereign debt stock to GDP ratio with a linear dependence (fragment of the calculation)

The deterministic dynamical model in a difference form looks like:

$$x(t+1) = -0.0629x + 524 \quad X(0) = X_0$$

The fixed point (equilibrium) of the system (the resulting time path of x(t)) is on the level of - 1.488. Any change to the parameter value is immediately reflected in a change to the equilibrium value [3, p.8]. The stability of equilibrium is starting with the value 0 and tending to the equilibrium of -1.488 (pointed "x star" on the spreadsheet). The system will always converge itself (in other words, oscillating between the repelling and attracting) to the equilibrium, whatever basic level is being chosen. Identically to [3] changing the parameter a the linear model, or 524 in our example will change the equilibrium value and changing the parameter b or -0.0629 ("system is oscillating, but converging on the equilibrium value" [3, p.10]) of the model will substantially change the initial fixed point, not depending on the sign (positive or negative). Under the parameter value b of 1 the model attains practically the negative form with the slight oscillations between periods of time and no fixed point. The economic sense of changing the parameter b is in making the economic decisions of transition from converging on equilibrium value without oscillation. Under current economic conditions the external financial position is under substantial risk of moving in the direction from stable equilibrium to "further and further from the equilibrium value" [3, p.10]. Current economic situation in national economy reflects the pessimistic scenario of moving away from the stable equilibrium value (in the direction of unique and global instability), despite of the fact, that the current equilibrium point has taken the form of an attractor fixed point.

Phase plot graphical solution. On the figure 2, presented below, "the fixed point is attracting the system from any position on either side" [3, p.13]. Session is presented by years of analysis. The sovereign debt behaviour is reflected by frequency of the problem. The figure shows us the possible parts of the sovereign debt cycle with an increasingly movement to a straight line.

Nonlinear dynamics:

The basic value of the sovereign debt time path, as in the linear case is proceeded from the zero level of sovereign debt in 1991 (X (0) = 0) but with two fixed points in the system and local instability. The recursive nonlinear system is presented in the form:

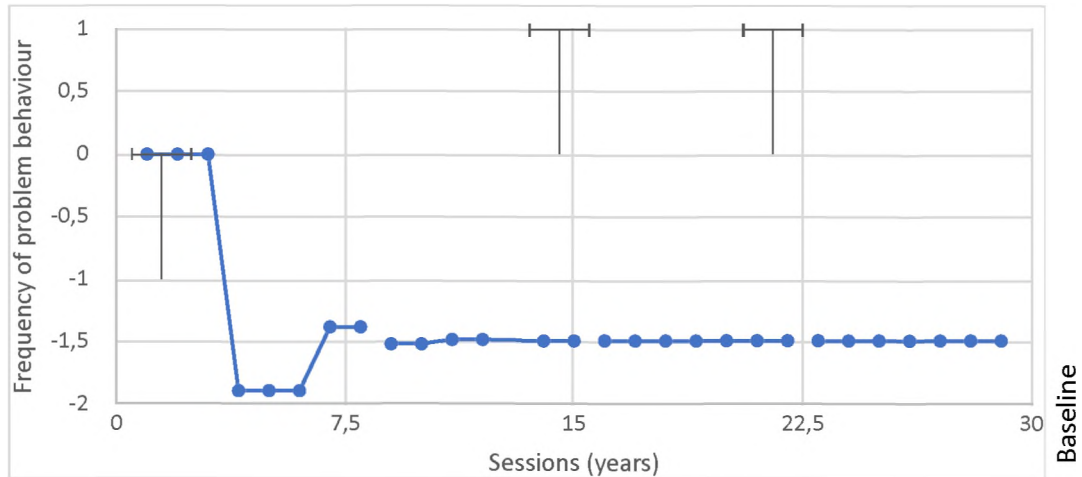$$x(t + 1) = - 0.007x^2 + 0.0161x - 0.1132 \qquad x(0) = 0$$

Figure 2. Phase plot graphical solution for sovereign debt dynamics

The calculation within the above presented formula (1) has created the nonlinear formula with the appropriate figure of the following type:
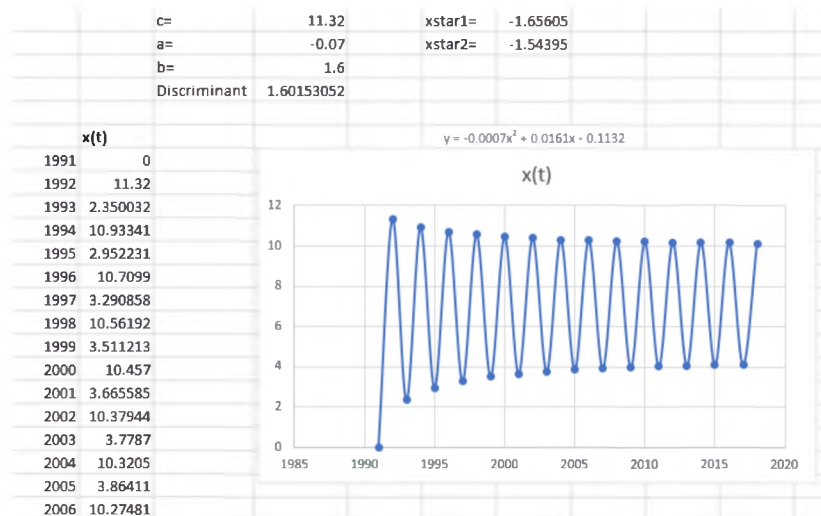

Figure 3. The fixed point as an equilibrium value for a country's sovereign debt stock to GDP ratio with a nonlinear dependence (fragment of the calculation)

Contrary to the case with the linear dependency, the system is starting to oscillate between the values of 0 and 11.

Simulation modelling. The stock and flows diagram has 2 reinforcing loops, which determine the of "snowball sovereign debt effect in national economy".
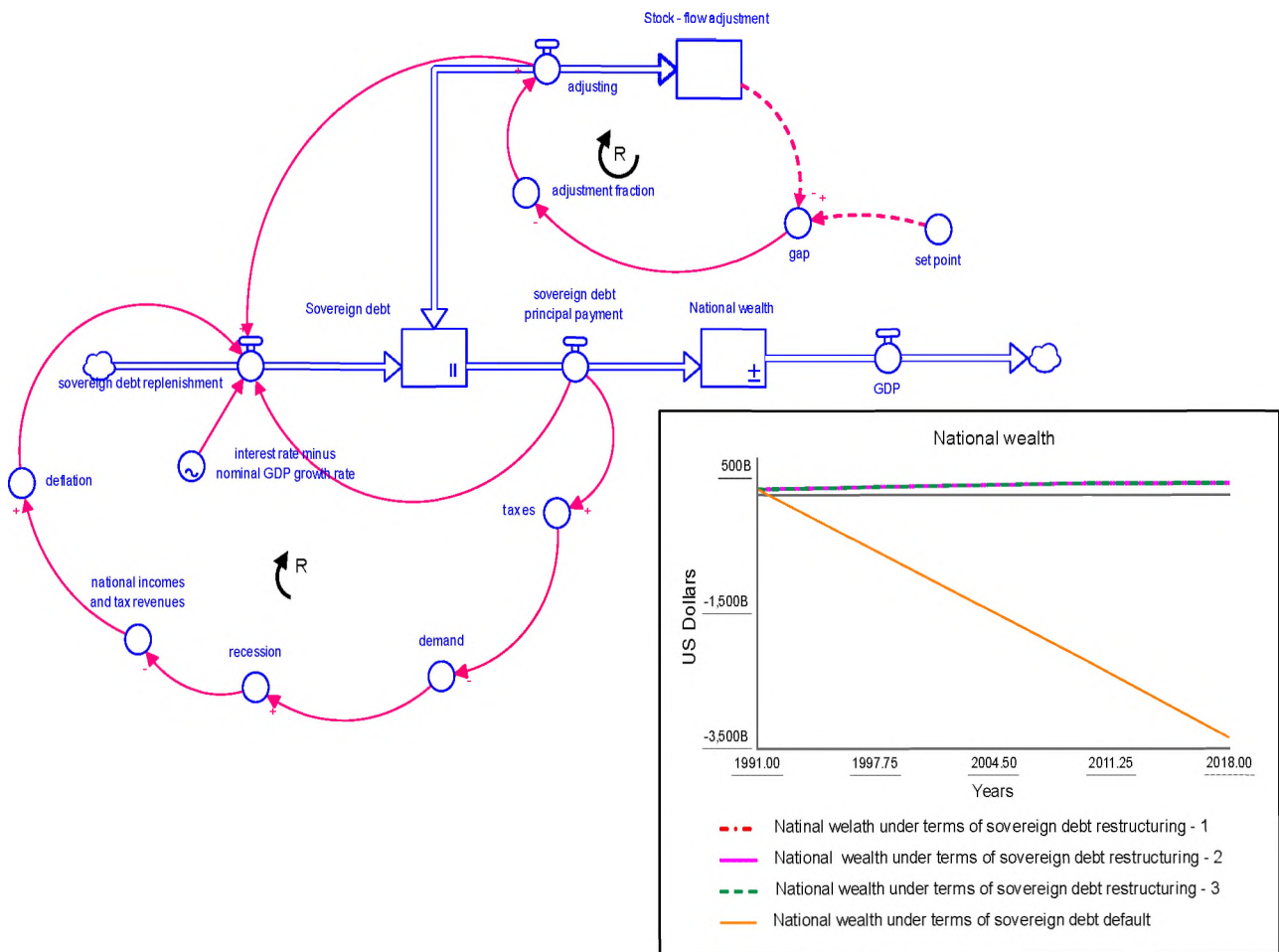
Figure 4. SD modelling and simulation analysis of sovereign debt in Ukrainian economy

The simulation modelling determines the current state of sovereign debt dynamics which still is not under condition of equilibrium in comparison with national wealth. The solid down sloping line (under sovereign debt default) indicates the current national wellbeing which needs to be improved to equilibrate the national debt market. Under scenarios under terms of sovereign debt restructuring the situation wilt national wellbeing will improve, but we need to reduce the sovereign debt substantially for this.

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