

### *References*

1. Wheat, I. D. (2007). MacroLab Documentation.
2. Sterman, J. D. (1984). Appropriate summary statistics for evaluating the historical fit of system dynamics models. *Dynamica*.
3. Sterman, J. D. (2000). *Business dynamics: System thinking and modeling for a complex world*. Boston: McGraw-Hill.
4. Official site of the State Statistics Service of Ukraine. URL: <http://www.ukrstat.gov.ua/>.
5. Лук'яненко, І., Віт, Д. (2017). Системний аналіз формування державної політики в умовах макроекономічної дестабілізації.
6. Лук'яненко, І., Віт, Д., Олісевич, М. (2020). Фінансова політика в умовах тінізації та дисбалансів на ринку праці: методологія та інструментарій.

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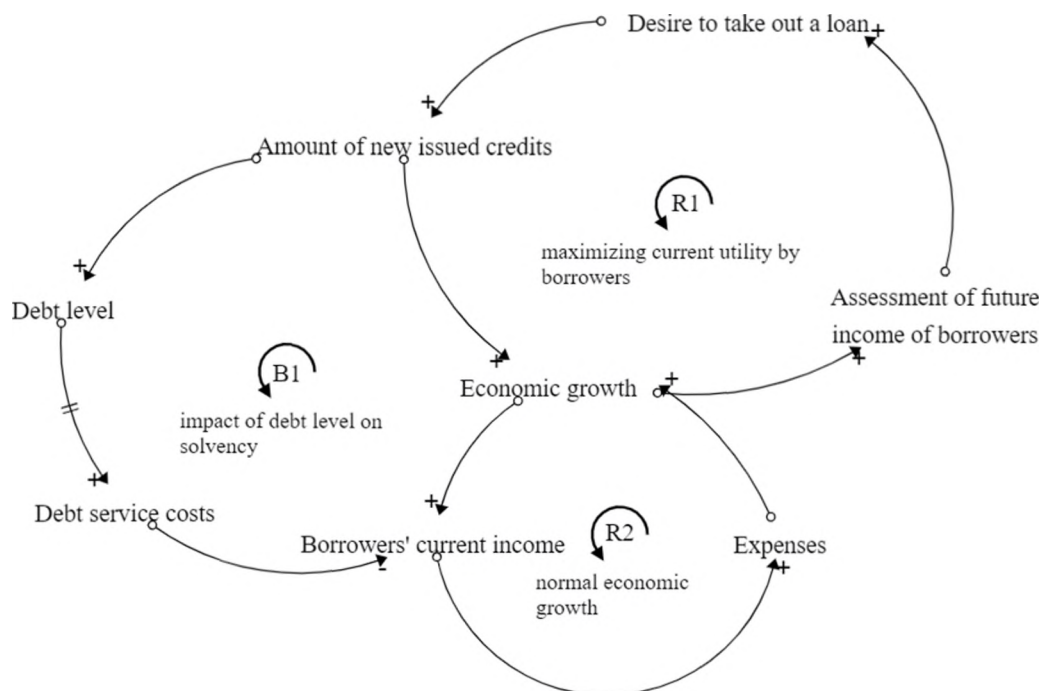
## **CONCEPTUAL FRAMEWORKS OF CREDIT SYSTEMS MODELING BY MEANS SYSTEM DYNAMICS TOOLS**

Modern credit market is a complex system with rapidly increasing dynamic. This raises many interdependencies between constituent elements of this system. One of such components is a set of interdependencies between market conditions and banks' performance. Basically, banks develop their credit strategies in accordance with credit market conditions. But when banks realize their strategies it is changing the condition of the market with some delay in time. It is a classical systemic effect. Typically changes concern the following market characteristics: Average deposit rate; Average time for issuing a loan; Average interest rate; Number of potential borrowers; Average banks' profitability.

In the aggregate way in the long term it is reflected as a cyclic pattern of the credit market growth. Cyclic pattern was the subject of the investigation of Hyman Minsky. In his work "Stabilizing an Unstable Economy" ([2]) he shed light on the reason for such behavior of the credit systems. According to Minsky cyclic growth is an inevitable result of income maximization by borrowers and creditors during the long terms of stability.

The cycle begins with a careful attitude to financing the invest projects by enterprises and the same careful assessment of risks by banks. Over time, enterprises borrow more and more to maximize their profits. The similar situation with consumer loans. As a result, the economy is growing and their expected income also. We applied system dynamic (SD) approach to modeling systems which provide lending activity.

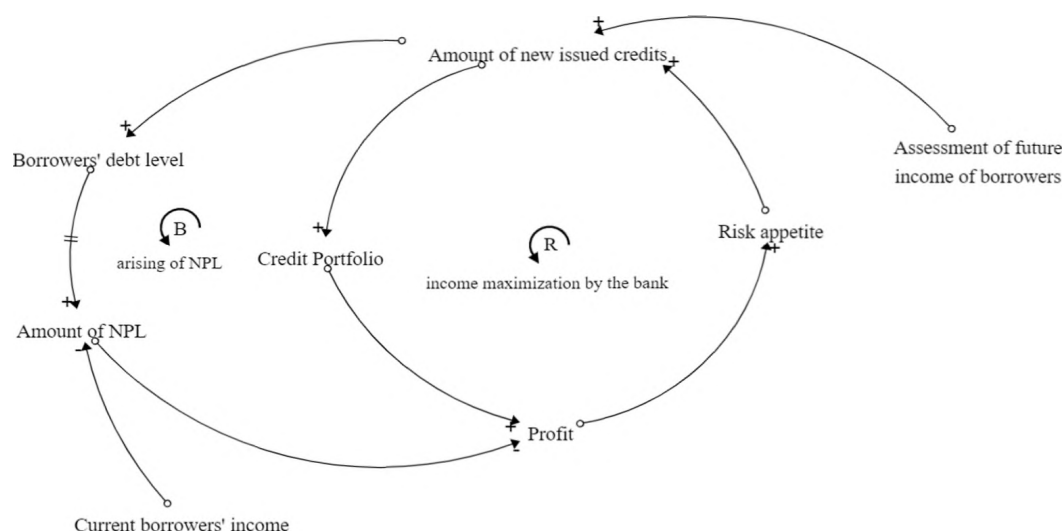
Minsky`s approach can be in very simple form depicted as a reinforcing loop R1 on Figure 1. Side effect of such borrowers` behavior is an increase in their debt level. As a result, the debt service costs decrease their income with a delay. It is depicted as a balancing loop B1 on Figure 1. So, one of the basic assumptions about reasons of crises is wrong assessment of future income of borrowers which lead to over lending them.



**Figure 1. CLD presentation of interdependency between growth of loan granting and borrowers' debt level**

Non-correct risk estimation by banks happened as a result of their profit maximization logic. The profit of a bank depends on the size of the credit portfolio and its quality. During the long time of stability banks typically have relatively low

level of NPL (non-performing loans). But their risk appetite grows and they increase lending of risky borrowers. This leads to increasing risk of bank's credit portfolio. It is depicted as reinforcing loop R1 on Figure 2. If income of borrowers differs from expected it increases NPL and decreases risk appetite of banks. It is depicted as balancing loop B1 on Figure 2.



**Figure 2. CLD of income maximization by bank**

This is one of conceptual basis for modelling credit system behaviors as a complex dynamic system. The main driver of its growth is income maximization by borrowers and banks. Their interactions reflect in the cyclic pattern of the credit market growth. Modelling by applying Stella Architect resource is a good pillar for modelling systems in dynamic.

### **References**

1. NBU, Financial Stability Report, June 2020 [Electronic source] – Access mode: <https://bank.gov.ua/ua/news/all/zvit-pro-finansovu-stabilnist-cherven-2020-roku>
2. Minsky, H. (2017). *Stabilizing an Unstable Economy*. translated by Kapturevsky, Y.. St. Petersburg
3. Kaminskyi, A., & Petrovskyi, O. (2019). Consumer Lending in Banks: System Dynamics Modelling. *Scientific Papers NaUKMA. Economics*, 4(1), 48–53. <https://doi.org/10.18523/2519-4739.20194.1.48-53>
4. Morecroft, J. D. W. (2015). *Strategic modeling and business dynamics: a feedback systems approach* (2nd ed.). New York, NY: Wiley.