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APPLICATION OF SYSTEM DYNAMICS METHODS IN MODELING AND FORECASTING THE VOLUME OF BANK LENDING

To turn loans into one of the key drivers of a country's economic development it is important to identify the determinants of the impact on loans by supply and demand based on credit relations between commercial banks, businesses and households.

Based on the application of system dynamics methods, the authors developed a simplified model that depicts the demand for bank loans from businesses and households in a generalized form and also the ability of commercial banks to meet this demand, reflects the links between these entities and can be used to calculate and forecast the volumes of bank loans.

The constructed system dynamics model presented below consists of three economic sectors where credit relations happen: 'Business entities', 'Households', and 'Commercial banks'. To understand the features of the model, we consider and analyze each sector in detail, identifying the model's parameters, the relationships between the elements and the behavior of the model as a whole (see Appendix A).

In Fig. 2-3 the identified sectors for the formation of demand for loans from businesses and households are highlighted.

The basis of the sectors 'Business entities' and 'Households' of the model is the stock variable "Balance of business entities (households)", which shows the balance of money and increases due to the inflows: income of business entities (households) and bank loans received. And, accordingly, it decreases due to the outflows: costs incurred through own and loaned money, deposits at commercial banks and other savings. Income and expenditures made with own money, as well as the volume of deposits and other savings are determined on the basis of exogenous variables (monthly time series

of income and expenditure of businesses and households). On the contrary, flows such as bank loans received and expenditures by loans occur when there is a demand for bank loans.

According to the model's assumptions, if the received income is smaller than the expected expenditures, there is a need to get loans, which is determined by the difference between income and expected expenditures. The actual volume of demand for loans is determined by taking into account the maximum value of the credit load. In the model, this indicator is a constant and expresses the maximum allowable ratio of the expected loan to equity for businesses, and for individuals – the maximum ratio of the expected loan to the average monthly salary weighted for the term of the loan. Accordingly, the amount of bank loans received is calculated according to the demand for loans, taking into account the fact that it does not exceed the maximum loan load and taking into account the maximum allowable supply of loans by commercial banks. In case of excess, – the amount of loans is equal to the supply of loans (lending base).

Thus, the amount of borrowed loans determines the total volume of loans (stock variable). Interest expenses for loans, which are included in total expenses, are determined on the basis of the amount of borrowed loans, the interest rate on the loan and its term. In addition, according to the volume of loans received and the term of the loan, the amount of monthly instalments on loans (repayment of the loan body) is calculated.

In the context of the «Commercial Banks» sector, performed modelling on the basis of a simplified version of the bank's balance sheet. This segment of the model is divided into two parts: the left part reflects the assets of a commercial bank, and the right one – its liabilities (Fig. 1).

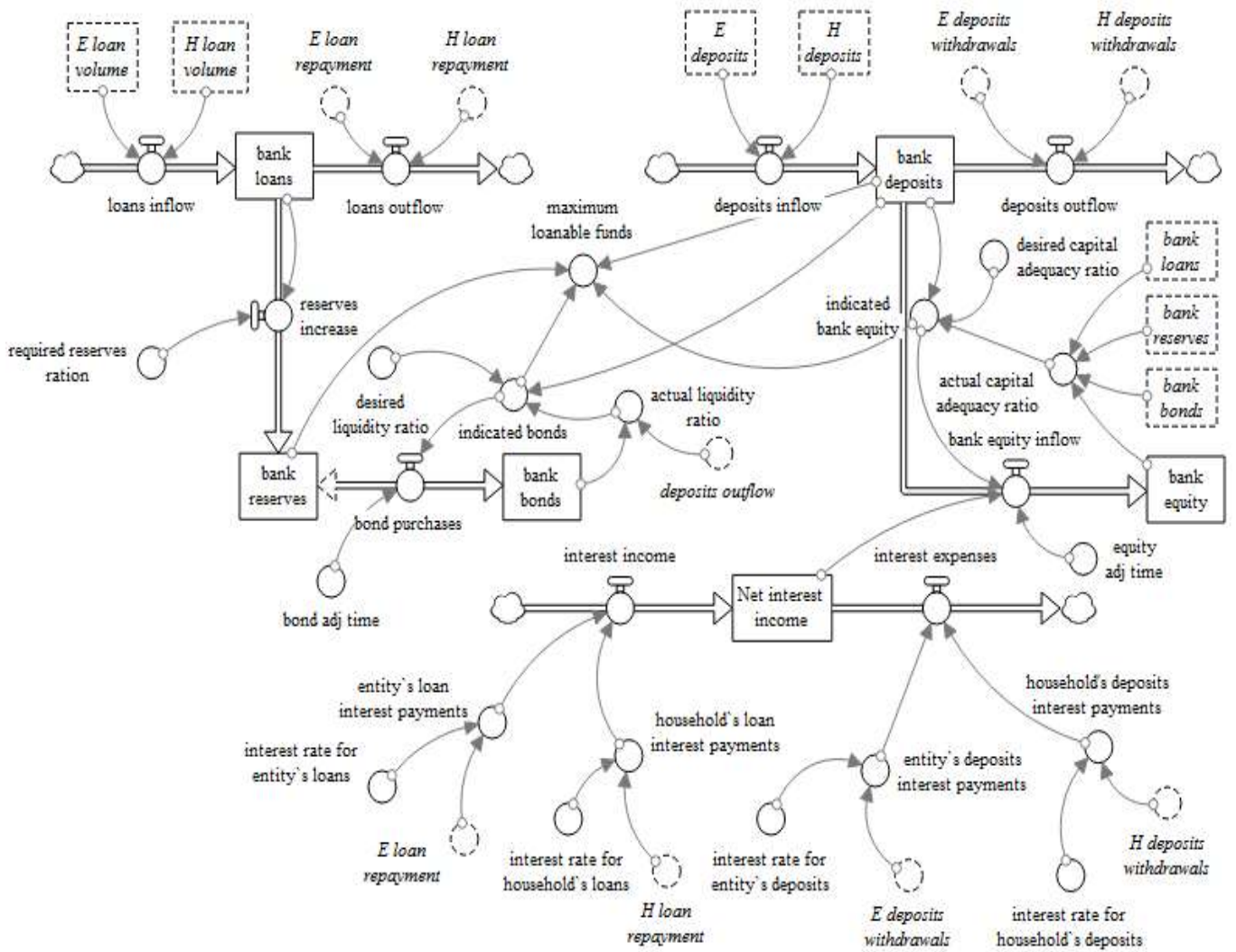


Figure 1. «Commercial banks» sector model of bank loans market using the methods of system dynamics

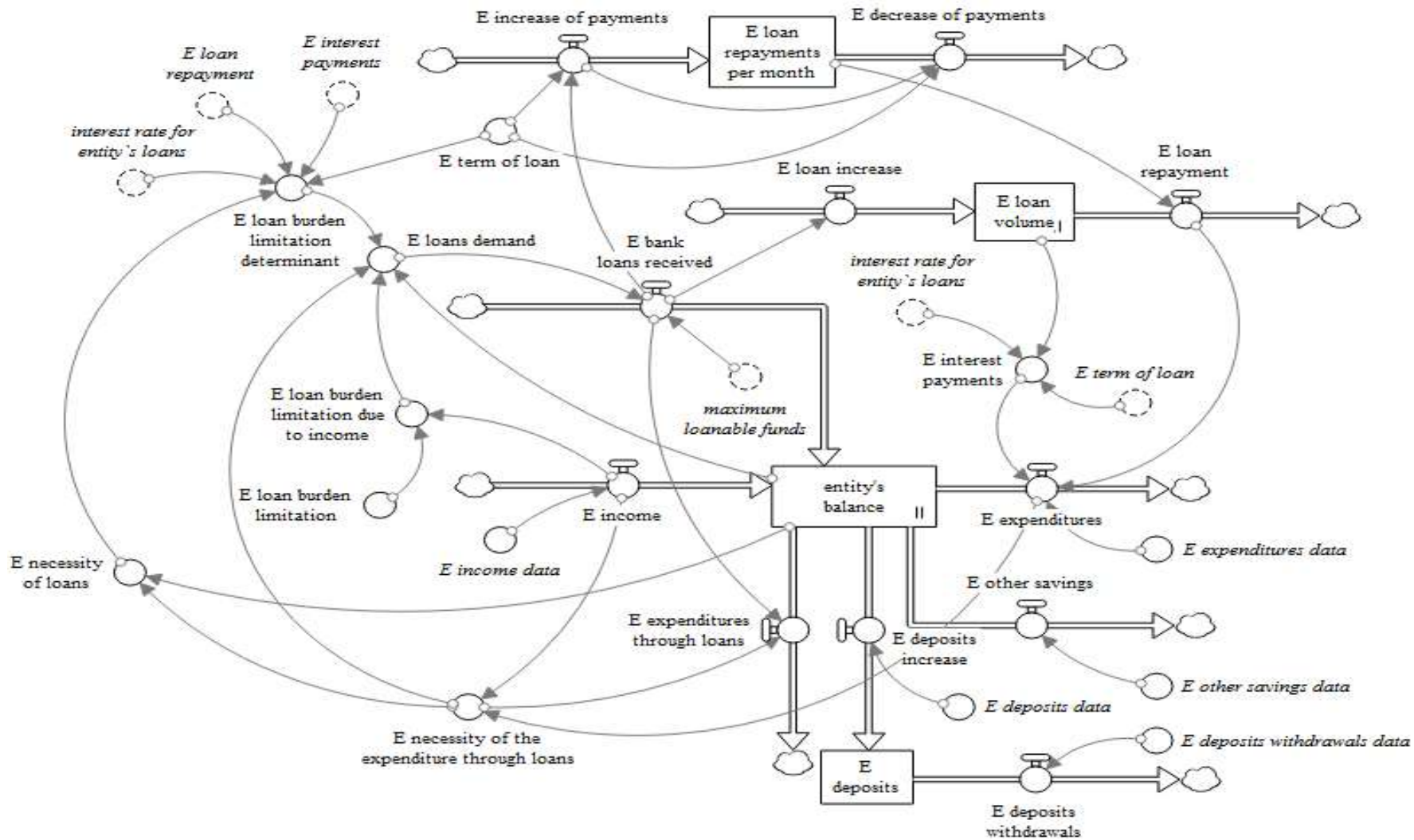


Figure 2. «Business» sector of the bank loans market model using system dynamics methods

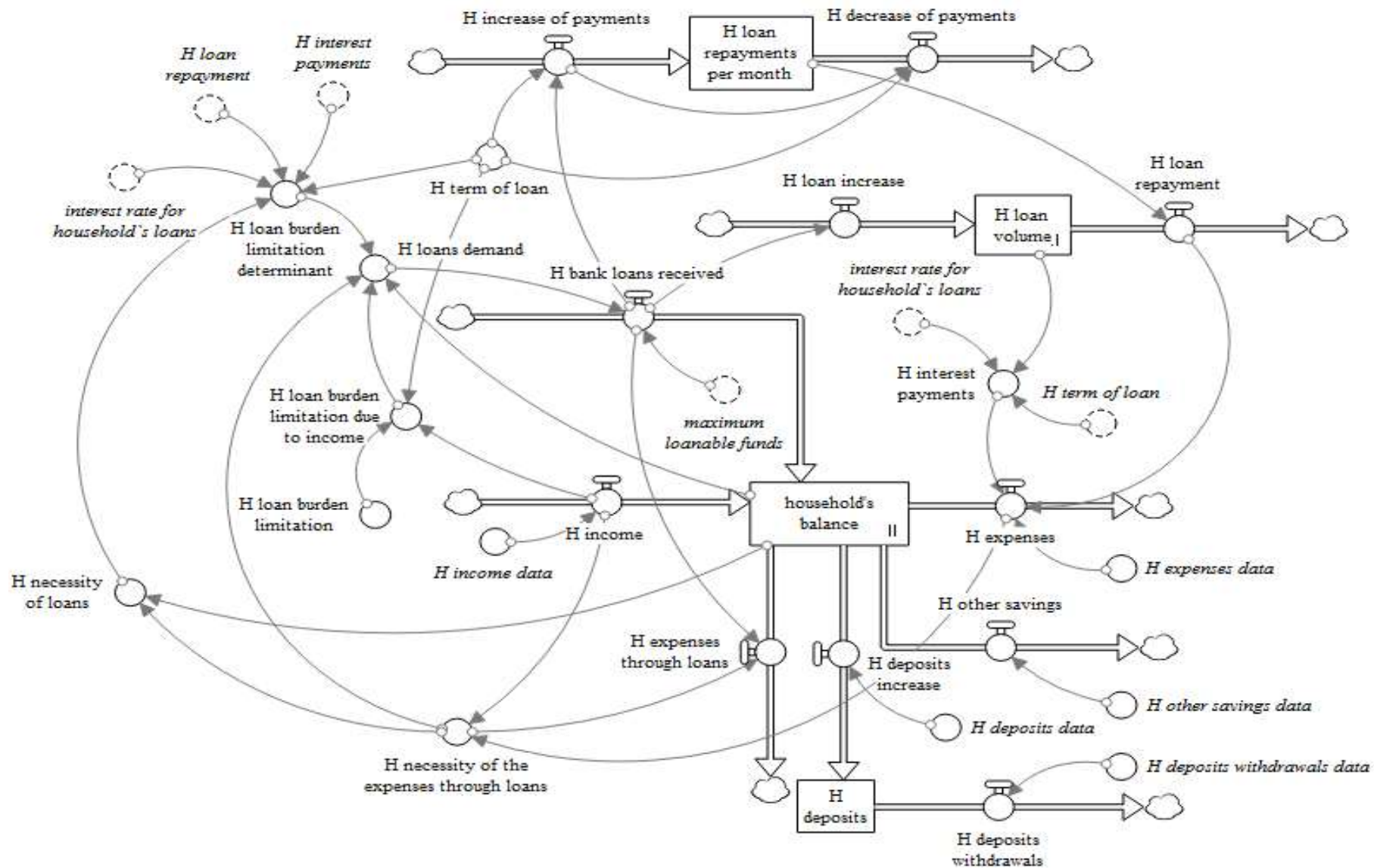


Figure 3. «Household» sector model of bank loans market using the methods of system dynamics

Part of the assets is represented by three stock variables: "Volume of loans", "Bank reserves" and "Volume of bonds". First, the value of the stock variable "Volume of bank loans" is determined: it increases due to the inflow (increase in loans) and decreases due to the outflow (the amount of repaid loans). These indicators are defined in the segments "Business" and "Households". Also, the stock variable "Bank reserves" reflects the volume of required reserves for the activities of banking institutions. Since commercial banks are required to maintain bank reserves in accordance with the NBU-established level, it was assumed that the reserves are defined as the volume of borrowings multiplied by the mandatory reserve ratio set by the NBU. In addition, the stock variable "Volume of bonds" is subject to adjustment to ensure the required level of liquidity of commercial banks. The model simplifies that the actual level of liquidity is calculated as the ratio of the expected outflow of deposits to the volume of bonds. Accordingly, if this indicator is smaller than the established regulatory level of liquidity, part of the funds raised by banks in the form of deposits goes to the purchase of commercial banks bonds (volume of deposits multiplied by the difference between the regulatory and actual value of liquidity).

Part of the liabilities is represented by two main stock variables: "Volume of deposits" and "Volume of equity". The stock-variable "Volume of attracted deposits" is determined by analogy with the stock variable "Volume of loans" in terms of assets: increases due to the inflow – (an increase in attracted deposits) and decreases due to the outflow – (the amount of deposits paid). These indicators are also defined in the segments "Business" and "Households". For simplicity, the stock variable "Equity" is growing due to the net interest income. In addition, it is assumed that the amount of equity is further adjusted according to the capital adequacy ratio. Its actual level is defined as the ratio of equity to net assets of the bank (loans and bonds minus reserves). Accordingly, if the actual capital adequacy ratio is less than standard the norm, then part of the funds raised by banks in the form of deposits is redirected to the capital of banks (volume of deposits multiplied by the difference between the regulatory and actual value of capital adequacy).

Thus, the maximum allowable amount of loans that can be provided by commercial banks (loan offer) is defined as the difference between attracted deposits (minus the part of deposits that goes to the purchase of bonds and equity formation) and reserves.

In addition, it should be noted that in the "Commercial Banks" sector there is a stock variable "Net interest income" (which was mentioned earlier as a determinant of growth of the stock variable "Equity"), which is defined as the difference between interest income and costs. Accordingly, interest income is defined as the amount of interest payments received for the use of loans from businesses and households. Then, the interest expenses of commercial banks consist of interest payments on deposits to businesses and households. This subsegment makes it possible to further investigate the effectiveness of the use of borrowed funds by commercial banks and the effectiveness of their lending activities.

Thus, the model makes it possible to trace the relationship between commercial banks and businesses and households. The volume of bank loans is calculated in accordance with the demand for loans (sectors "Business" and "Households"), weighted by the maximum amount of credit load, provided that this amount does not exceed the maximum allowable lending base defined by commercial banks (sector "Commercial banks»).

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