its direct role in production, but also indirectly. Capital contribute to development of new ideas and make all other capital more productive.

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SYSTEM DYNAMIC MODELING FOR BANKING SYSTEM

One of the consequences of the banking crisis in 2014-2016 in Ukraine was the closure of a significant number of banks (fig. 1). During that period 90 banks were declared insolvent. In 2014 the National Bank of Ukraine was unable to prevent the closure of a large number of banks, as it was not ready to act during a sharp deterioration in the economic and political situation. After this banking crisis the NBU began to pay a considerable attention to stress testing of the banks, the purpose of which is to check the resilience of the banks to possible shocks. Therefore, the aim of research is to reflect the impact of changes in performance indicators of the banks and economic situation on bank's stability. The model was built for Privatbank, the stability of which is very important for the Ukrainian banking system. PrivatBank is the largest Ukrainian state-owned bank in terms of assets, which was fully recapitalized by the government in 2017 after the NBU declared it insolvent.
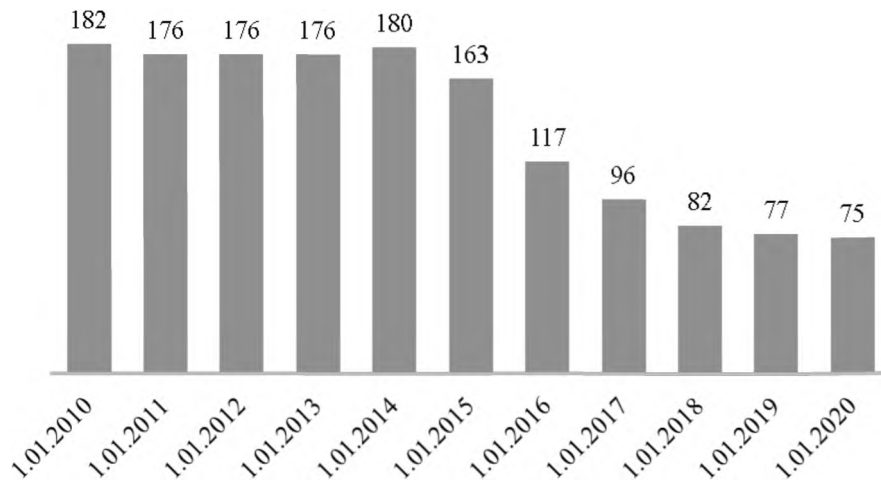
Figure 1. The number of banks in Ukraine during 2010-2020

The stress testing procedure includes the adequacy of the bank's regulatory capital check. Regulatory capital main purpose is to cover the negative consequences of various risks that banks take in the course of their activities, and to ensure the protection of deposits, financial stability and stable operation of banks [1].

Regulatory capital adequacy is an economic standard established by the National Bank of Ukraine, which reflects the bank's ability to pay its obligations on time and in full. It is determined as regulatory capital divided on a sum of risk-weighted assets and foreign exchange position less uncovered credit risk. According to legislation Regulatory capital adequacy should be not less than 10% [1].

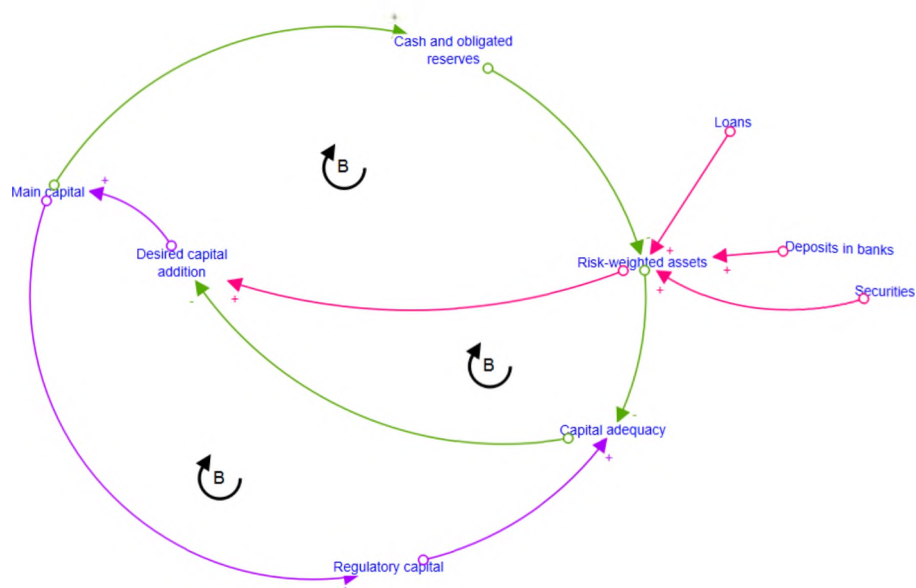CLD shows the logic of interconnections in the model (fig. 2).

Figure 2. Causal loop diagram for capital adequacy ratio of the bank

If risk-weighted assets increase, bank needs more money to cover those risk assets and accordingly to ensure the stability of the bank, as a result desired capital addition increases. If desired capital addition increases, it means that the bank needs to be recapitalized, so main capital increases. Then the increase in capital is reflected in the least risky assets of the bank, so risk-weighted assets are reduced. But at the same time an increase in risk-weighted assets negatively affects the capital adequacy ratio. If capital adequacy ratio is high, bank doesn`t need more money to add in capital. Further, as discussed earlier, an increase in the desired capital addition causes an increase in main capital, which in turn has a positive effect on regulatory capital and, consequently, on the adequacy ratio.

One of the main components for calculating capital adequacy is the amount of risk-weighted assets. In order to develop a part of the model that reflects the assets of the bank, the main assets were chosen that are reflected in the balance sheet of Privatbank. On figure 3 these assets can be seen in the form of stocks that reflect the book value of these assets. In order to define the amount of risk-weighted assets, all assets of PrivatBank were weighed for a specific risk determined by the NBU.
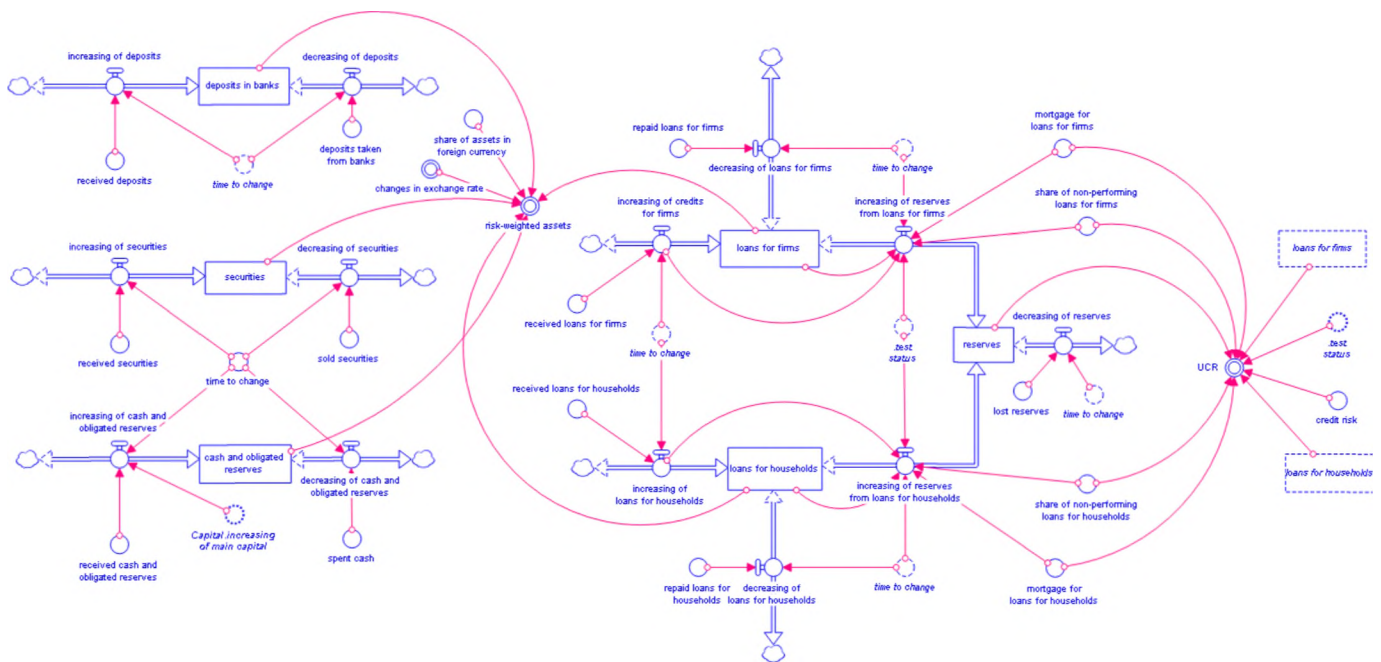

Figure 3. Assets structure of the bank

The most difficult part of the assets structure is related to loans and formation of reserves for credit operations. In accordance with International Financial Reporting Standard 39, the formation of reserves for possible losses from active operations is used by banks to recognize reduces the book value of loans. The amount of such reserves is determined as part of the value of negatively classified assets, which the bank with some degree of reliability, based on previous experience, may consider lost and therefore attributed to the costs of its activities [6].

In order to calculate the amount transferred to reserves, it was taken the book value of loans (including loans issued during this period), identified the share of non-performing loans (overdue payments for 90 days) and deducted mortgages on loans. It is also important to note the formation of uncovered credit risk in the model, as it directly affects the adequacy ratio, as well as changes in the regulatory capital of the bank. Uncovered credit risk is a risk that exceeds the amount of formed reserves. Its change is influenced by the share of nonworking bank loans.

The bank's regulatory capital consists of a main and additional capital. Main capital is a more stable part of regulatory capital, and additional is more variable. It is important to note that the excess of uncovered credit risk over annual income contributes to the reduction of regulatory capital. Also if it is necessary to increase the amount of regulatory capital to achieve the required level of regulatory capital adequacy, the amount of the increase is sent to main capital and will be stored as required reserves, which are the least risky assets.
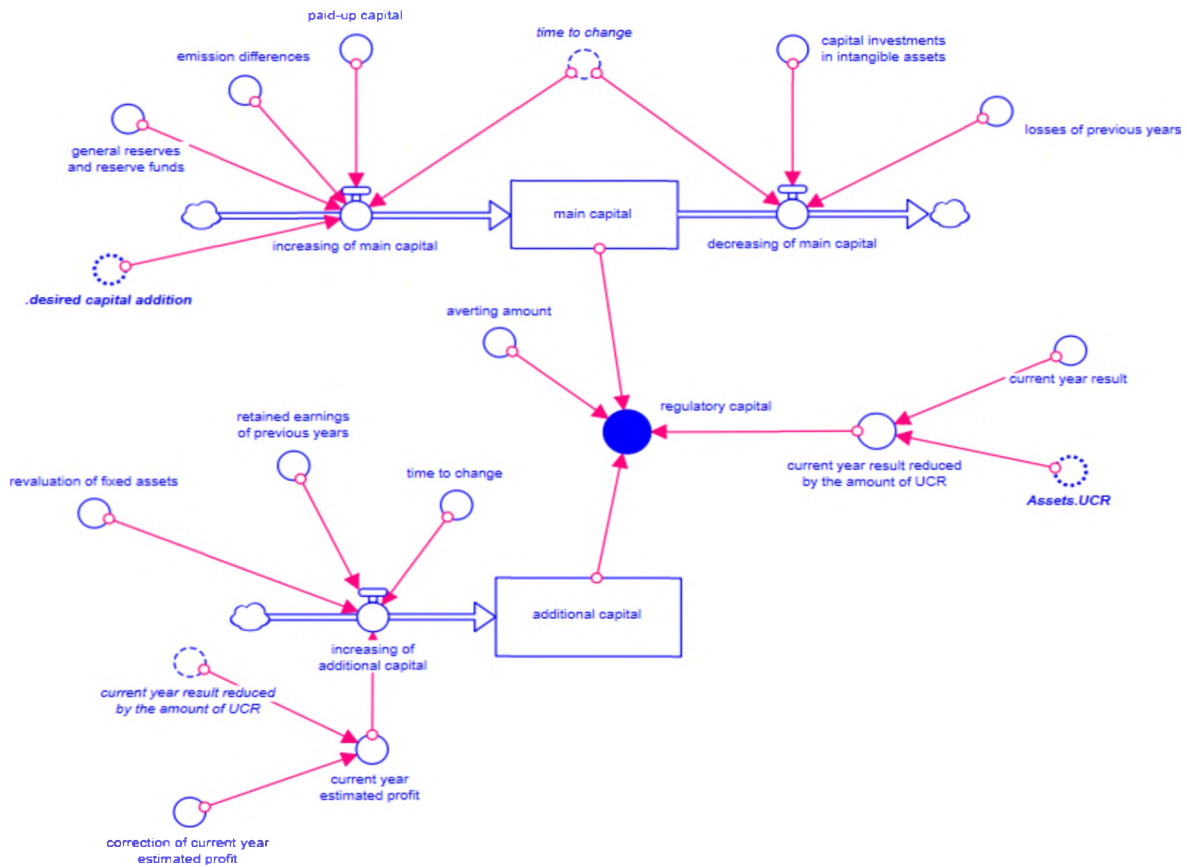
Figure 4. Regulatory capital structure of the bank

The simulation shows that the value of the ratio calculated in the model slightly differs from the actual ones (table 1).

Table 1. Actual and simulated ratios of regulatory capital adequacy

Year	Regulatory capital adequacy norm	Actual regulatory capital adequacy	Regulatory capital adequacy model simulation
2018	>10%	17.46%	17.5%
2019	>10%	14.15%	14.8%

Three negative scenarios were considered. The first is an increase in the share of non-performing loans by 20%. The second is the devaluation of the national currency by 84% (as during the deterioration of the economic situation in 2014). The third is a combination of the two previous scenarios. Received during simulation of those scenarios adequacy ratios are shown in table 2. An increase in the share of non-performing loans causes decreasing of capital adequacy on 1.2%. The devaluation of

the national currency causes decreasing of capital adequacy on 2.2%. Combination of two shocks causes decreasing of capital adequacy on 3.5%. So, in all negative scenarios PrivatBank meets the requirements of the regulatory capital adequacy.

Table 2. Regulatory capital adequacy scenarios simulations

Year	Regulatory capital adequacy norm	Actual regulatory capital adequacy	Regulatory capital adequacy Scenario 1	Regulatory capital adequacy Scenario 2	Regulatory capital adequacy Scenario 3
2019	>10%	14.15%	13.6%	12.6%	11.3%

So, stress testing of banks plays an important role in banking system regulation because it is an effective tool for checking the resilience of banks to possible shocks. For further use of this model in dynamics it is necessary to determine the logic of formation of all types of assets by changing the liabilities of the bank; to endogenize the calculation of some variables of the model to reflect the dynamics of the regulatory capital adequacy at least for 5 years; and to add the structure of the bank's recapitalization policy implementation.

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