the shock, which hit the economy, the consequences of macroprudential regulatory actions for monetary policy can vary. In some cases, these policies can resemble each other, whereas sometimes even the agreed actions do not allow for muting the vulnerability of main economic variables in response to shocks. In general, there is an agreement between authors that macroprudential instruments suit to address financial stability disturbances, while monetary policy showed itself as efficient in terms of its main goals.

From the technical point of view, mentioned research used primarily DSGE with inbuilt monetary policy rules. At the same time there is a variety of ways to present macroprudential policy. It was done either with discretionary changes in instruments or with some macroprudential policy rules. But what seems to be interesting and promising regarding further steps in analysis is to implement the macroprudential goals the same as output and inflation expectations into the monetary policy rule. In this case, the possible contradiction between macroprudential and monetary instruments would be muted within the system by adjustment of core interest rate in order to react to both macroeconomic parameters and financial stability indicators.

Hence, monetary and macroprudential policy interaction is a complicated issue that needs practical investigations which can be performed with dynamics modeling. At the same time, it can be proven with modeling that both policy instruments can be efficient if applied to right tasks. Moreover, it is possible to achieve even better results if take into account both policies goals while setting the rules.

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## MODELING EXCHANGE RATE IN UKRAINE USING SYSTEM DYNAMICS METHOD

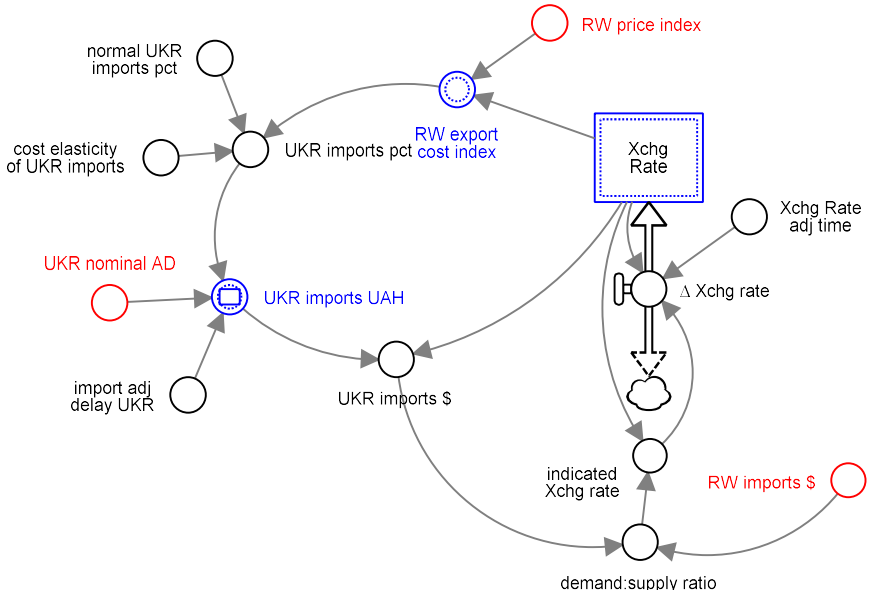
In late 2014 Ukraine faced the change of exchange rate regime and after continuous existence under the terms of fixed exchange rate regime it established floating exchange rate regime. Since 2015 exchange rate has been experiencing instability as it is determined by free trade powers and isn't set by national bank regulator any more. Exchange rate has a significant impact on the goods' prices for export, so on the amount of export and revenues of export oriented producers, the level of competitiveness of Ukrainian goods abroad, the level of inflation and the burden of foreign debt to be repaid in foreign currency; it influences import just the opposite compared to export. Therefore, modeling exchange rate in Ukraine due to the methods of system dynamics can help to analyze the problem of volatility of the exchange rate (graph 1) [1, 4].

Considering the main hypothesis in the submodel, it may be emphasized that: when RW imports in $ rise more than Ukrainian imports in $, the value of the exchange rate falls; when Ukrainian imports in UAH rises faster that exchange rate, Ukrainian imports in $ rises; increasing in exchange rate adj time causes the delay in delta exchange rate, therefore, the exchange rate should change more slowly; decreasing in UKR imports percentage cause Ukrainian imports in UAH to decrease.

Comparing the model structure with real knowledge about the real system it may be achieved an adequacy of the model, because each relationship described the problem in real Ukrainian situation. Importantly, all variables and calculations follow real-world data which are taken from official sites.

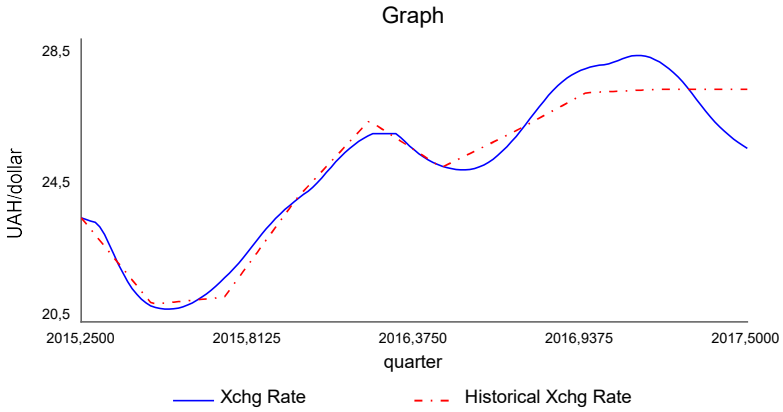
Following the trend of historical data of the exchange rate, one can see that the exchange rate is truly volatile, but simulating the model shows that the model data and historical coincide (graph 2). With regard to the exchange rate model, the mean square error is 0,0834 stats^2 (so UAH/Dollar^2). In terms of error sources, there is an appropriate division of the total error of 0,0834 into bias that makes

up 13,1 %; variation – 30 % and covariation that is 56,9%. Therefore there is no reason to assume that the error is systematic and hinders accuracy of the built model.




Graph 1. **The simplified view of the Exchange rate model**

All models are simplified representations of real-world mechanisms and systems that govern the observed behavior we wish to investigate. It is therefore of vital importance that the model that was constructed can be validated through empirical, logical and numerological tests to build confidence in results and system. Therefore structure, parameter confirmation and dimensional consistency tests were conducted. In addition, extreme condition test checked if the model responds plausibly when extreme policies, shocks or parameters are changed. For this purpose, step-function was used. Also, to test the exchange rate sensitivity, an appropriate test was used that used the cost elasticity of UKR imports and import adj delay UKR to validate. According to the analysis, it was able to determine in which limits described parameters should be in order to best correspond to real historical data. Likewise, this test confirmed our hypothesis regarding the effects of the cost elasticity of UKR imports and import adj delay UKR that were mentioned above.




Graph 2. **Comparison of model and historical data of the exchange rate**

Exchange rate model has some specific advantages. Strengths of the model encompass clarity in data representation, which is undoubtedly suitable for users of many kinds, data validity due to low errors, parameter adjustment and a range of parameters to choose from sensitivity analysis background. Opportunities that may occur are expansion of the time horizon, which will enable the exchange rate under the floating regime to develop more; improvement of financial market in Ukraine that can be used as another influence on exchange rate. A technical opportunity is an optimization tool that will help raise the flexibility of model testing.

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## MACROPRUDENTIAL REGULATION OF THE BANKING SYSTEM IN UKRAINE: SYSTEM DYNAMICS MODEL

The great Revolution in 2014 caused many terrible consequences. One of those is a crisis of banking system. More than 80 banks became bankrupt between 2014 and 2016. Below you can see the dynamic of banks liquidation (Graph 1).

There are several reasons for the mass liquidation of the banks: fraudulence and money laundering, business operations in Crimea and occupied territories, owners' independent choice and insolvency and lack of liquidity. In 2014 when suddenly reliable banks started to go bankrupt, wide scale panic for the state of savings and deposits caused people to started withdrawing money, which trickled down to other banks' sustainability. So, main point of the project is to demonstrate the influence of people's panic and recreate the situation of banking crisis.


Graph 1. **Number of Operational banks between 2008 and 2017**

The model of Ukrainian banking system has been built using the system dynamics method. The main assumption in the model is that commercial banks receive deposits, which they put in their own reserves, and this money is then given in the form of loans. All banking operations depend on money adequacy, which in turn is influenced by inflation, currency exchange, loan interest rate and money supply. The liquidity is an indicator of banks' sustainability, that effect on money adequacy and the amount of deposits. Notice, that Ukrainians do not trust banks, so it is important to consider people's anxiety. There is a stock "people's perception of money adequacy" that shows people's wariness about their savings and awareness of possible crisis. In the model, lack of money adequacy increases people's anxiety, and makes people withdraw money.

The most important part is the analysis of the model. To find the correct parameter values that make model correspond to the reality many various test have been made, such as sensitivity analysis of the parameter values, different shocks of variables' initial values and Theil Statistics to see the accuracy of the found values. As the idea of the paper was to recreate the situation that happened between 2014 and 2016, one of the tasks of the project was to compare model's behavior with average and historical discount and deposit rates. Below on the graphs of the main model stocks you can see that the